

Enterprise Interoperability Framework

David Chen

LAPS/GRAI, University Bordeaux 1, 351, Cours de la liberation,
33405 Talence cedex, France
david.chen@laps.u-bordeaux1.fr

Abstract. *This paper aims at presenting an enterprise interoperability framework elaborated within the frame of INTEROP Network of Excellence*. The purpose of the framework is to identify the basic dimensions regarding to enterprise interoperability and to define its research domain as well as to identify and structure the knowledge of the domain.*

1. Basic concepts and definitions

Enterprises are not interoperable because there are barriers to interoperability. Barriers are incompatibilities of various kinds and at various enterprise levels. The incompatibilities obstruct the sharing of information and prevent from exchanging services. There exist common barriers to all enterprises whatever the sector of activities and size. Developing interoperability means to develop knowledge and solutions to remove the incompatibilities (Chen *et al.* 2005, 2006).

The approach adopted is to: (i) define the domain of enterprise interoperability through the elaboration of an interoperability framework using barriers-driven approach; (ii) identify and structure the knowledge (solutions) of the domain using the framework. The interoperability framework proposed is elaborated on the basis of concepts developed in some existing frameworks and models (EIF, 2004), (ERISA, 2004), (IDEAS, 2002), (ATHENA, 2003), focusing on those concepts most relevant to define the research domain of enterprise interoperability.

1.1 Interoperability barriers

Three categories of barriers (conceptual, technological and organisational) are identified as follows:

- Conceptual barriers: They are concerned with the syntactic and semantic differences of information to be exchanged. These problems concern the modelling at the high level of abstraction (such as for example the enterprise models of a company) as well as the level of the programming (for example XML models).

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- Technological barriers: These barriers refer to the incompatibility of information technologies (architecture & platforms, infrastructure...). These problems concern the standards to present, store, exchange, process and communicate the data through the use of computers.
- Organisational barriers: They relate to the definition of responsibility (who is responsible for what?) and authority (who is authorised to do what?) as well as the incompatibility of organisation structures (matrix vs. hierarchical ones for example).

1.2 Enterprise levels

Interoperations can take place at the various enterprise levels. Although the following categorisation is mainly given from a point of view of IT based applications, it applies to non-computerised systems as well. It is based on the ATHENA Technical architecture (ATHENA, 2005).

- The interoperability of **data**: It refers to make work together different data models and query languages. The interoperability of data is to find and share information from heterogeneous bases, and which can moreover reside on different machines with different operating systems and data bases management systems.
- The Interoperability of **services**: It is concerned with identifying, composing and making function together various applications (designed and implemented independently). The term 'service' is not limited to the computer based applications; but also functions of companies and networked enterprises.
- The interoperability of **processes**: It aims to make various processes work together: a process defines the sequence of the services (functions) according to some specific needs of a company. In a networked enterprise, it is also necessary to study how to connect internal processes of two companies to create a common process.
- The interoperability of **business**: It refers to work in a harmonise way at the level of organization and company in spite of for example, the different modes of decision-making, methods of work, legislations, culture of the company and commercial approaches etc. so that business can be developed between companies.

1.3. Interoperability approaches

Research on interoperability is not only a matter of removing barriers but also in the way in which these barriers are removed. According to ISO 14258 (1999), there are three basic ways to relate entities (systems) together to establish interoperations:

- Integrated approach: there exists a common format for all models. This format must be as detail as models. The common format is not necessarily a standard but must be agreed by all parties to elaborate models and build systems.
- Unified approach: there exists a common format but only at a meta-level. This meta-model is not an executable entity as it is in the integrated approach but provides a mean for semantic equivalence to allow mapping between models.
- Federated approach: there is no common format. To establish interoperability, parties must accommodate on the fly. Using federated approach implies that no partner imposes their models, languages and methods of work. This means that they must share an ontology.

2. Enterprise interoperability framework

Based on the basic concepts discussed in section 1, the two basic dimensions of the proposed enterprise interoperability framework are shown figure 1: (i) Enterprise dimension representing enterprise levels (interoperability aspects), (ii) Interoperability dimension representing interoperability barriers.

| barriers levels | CONCEPTUAL | TECHNOLOGICAL | ORGANISATIONAL |
|--------------------|------------|---------------|----------------|
| BUSINESS | | | |
| PROCESS | | | |
| SERVICE | | | |
| DATA | | | |

Figure 1. The Enterprise interoperability framework (two basic dimensions)

The intersection of a level category (line) and a barrier category (column) constitutes a sub-domain. Thus this Interoperability Framework defines the enterprise interoperability research domain by the set of sub-domains which compose it. It can also be used to structure interoperability knowledge. A piece of knowledge is considered as relevant to interoperability if it contributes to remove at least one barrier at one level.

| barriers levels | CONCEPTUAL | | TECHNOLOGICAL | ORGANISATIONAL |
|--------------------|------------|-----------|---------------|---------------------|
| | SYNTAX | SEMANTICS | | |
| BUSINESS | UML V1.0 | A* | PSL | semantic annotation |
| PROCESS | | | | |
| SERVICE | | | | |
| DATA | | | | |

Enterprise Interoperability Domain
 (indicated by an arrow pointing to the top-right corner of the table)

An Enterprise Interoperability sub-domain
 (indicated by an arrow pointing to the cell containing '- Problem', '- Knowledge', and '- Solution')

Figure 2. Use of the framework to define the domain and to structure knowledge

Figure 2 shows the interoperability framework with the conceptual interoperability barriers further detailed into syntax barrier and semantic barrier. It also shows the use of the framework to identify and categorise the knowledge. A piece of knowledge may concern more than one barrier and cover more than one level. For example, UML V1.0 aims at removing syntactic barrier for enterprise model interoperability

and covers all the four levels, while PSL (Process Specification Language) contributes to remove both syntactic and semantic barriers but is limited to process level.

The third dimension (Interoperability approaches) is added to the two dimensional framework (see figure 3). This third dimension allows categorising knowledge and solutions relating to enterprise interoperability according to the ways of removing various interoperability barriers.

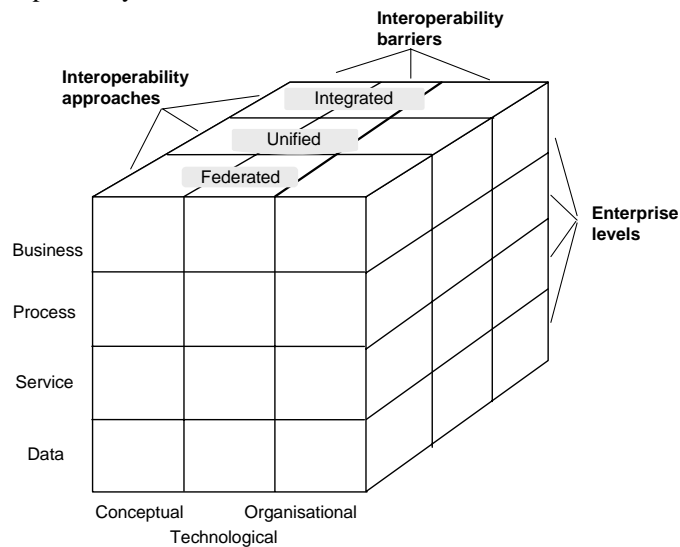


Figure 3. Enterprise interoperability framework (three basic dimensions)

For example, PSL contributes to remove *conceptual* barrier (both syntax and semantics) at the level of *process* through a *unified* approach. Concerning the semantic annotation technique, if the annotation and mapping are done using pre-defined reference ontology, then it is a unified approach. On the other hand, if the annotation and mapping are performed through negotiation on the fly, then it is a federated approach.

3. Conclusion

This paper presented a framework based on a barrier-driven approach to define the research domain of enterprise interoperability. Research activities (problems and solutions) can be mapped and structured with respect to the enterprise levels concerned, interoperability barriers tackled and approaches used to remove the barriers. The framework can be enhanced by some complementary dimensions: (i) *Interoperability knowledge* types, (ii) *Interoperability engineering phases*, (iii) *Interoperability measurements*. Future works are concerned with: (1) refining the interoperability framework, in particular the barriers to interoperability dimension, (2) identifying and mapping available enterprise interoperability knowledge/solutions to the framework.

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