Enterprise interoperability measurement - Basic concepts

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Abstract. Developing or improving enterprise interoperability implies that the level or degree of interoperability is evaluated and causes identified and analysed. This paper tentatively presents the basic concepts relating to the measurement of the degree of interoperability. The degree of interoperability of an enterprise can be characterized by three types of measures: interoperability potentiality, compatibility and performance. The last two measures are discussed in detail and some metrics are proposed. The proposed approach is rather straightforward using the most salient characteristics known today for each measurement. It is prospective and preliminary. Some discussion and future development are given in the conclusion.

1 Introduction

Interoperability is defined as the ability for two (or more) systems or components to exchange information and to use the information that has been exchanged [1]. To day few methods are developed to implement an interoperability solution and to evaluate the degree of interoperability. The measure of the degree of interoperability allows knowing the strengths and weaknesses of a company. This measure could lead to the improvement of interoperability, and to avoid deficiencies. Thus, developing interoperability measurement is becoming an important challenge. Some works have already been performed in this domain [2], [3], [4], however it is difficult to define metrics, mainly due to the difficulty to identify the parameters to characterise the interoperability. The concepts and principles presented in this paper tentatively tackle this problem by adopting a barriers driven approach.

2 Basic concepts and principles

Interoperability measurement aims at defining metrics to qualify the degree of interoperability. The implementation of metrics, in order to measure the degree of interoperability is related to two principles: (1) the identification of the parameters relating to interoperability, (2) the characterization of these parameters by metrics.

2.1 Interoperability barriers

Enterprises are not interoperable because barriers to interoperability do exist. Barriers are incompatibilities of various kinds and at various enterprise levels. There exist common barriers to all enterprises whatever the sector of activities and size. As a consequence, interoperability can be seen, in a first time, as a problem of compatibility between two systems, not only at ICT level, but all levels of enterprise. Thus developing interoperability means to develop knowledge and implement solutions which remove incompatibilities. Three categories of barriers are identified [5]: **conceptual** (syntactic and semantic), **technological** (related to the computer technology) and **organisational** (responsibility/authority, organisation structure).

2.2 Interoperability degree

The degree of interoperability is a measure allowing characterising the ability of interoperation between two enterprises (or systems). Metrics would enable for the partners to know their agility in term of interoperation. At the current stage of research, three types of measurement are considered: (1) Interoperability **potentiality measurement**, (2) Interoperability **compatibility measurement**, and (3) Interoperability **performance measurement**. The interoperability degree of a given enterprise or a system can be defined by a vector characterised by the three measurements mentioned above.

2.3 Interoperability degree measures

The potentiality measurement is concerned with the identification of a set of system properties that have impact on the interoperability development. These measures are performed on one enterprise/system without knowing the interoperation partner. The objective is to evaluate the potentiality of the system to evolve dynamically to adapt and to accommodate with respect to potential partners. For example, an open system has a higher potential of interoperability than a closed system.

The compatibility measurement has to be performed during the engineering stage *i.e.* when systems are re-engineered in order to establish interoperability. This measure is performed when the partner/system of the interoperation is known. The measure is done with respect to the identified barriers to interoperability. The highest degree of compatibility means that all the barriers to interoperability are removed. The inverse situation means the poorest degree of interoperability.

The performance measurement has to be performed during the operational phase *i.e.* run time, to evaluate the ability of interoperation between two cooperating enterprises. In [6], a basic interoperation cycle has been defined with three phases (exchange information, use information exchanged). Criteria such as cost, delay and quality can be used to measure the performance with respect to barriers and levels during a basic interoperation cycle. Therefore, each types of measurement have to be valued with local coefficients in order to get a global coefficient ranging from “poor interoperability” to “good interoperability”.

3 Interoperability measurement techniques

3.1 Metrics for potentiality measures

Interoperability potential is related to some intrinsic properties of a system. These properties are usually built at the design stage into the system using some design principles for interoperability. The figure 1 shows the most important properties giving high potentiality to a system to adapt in particularly in a federated environment.

Properties			
Open (1)	Decoupled (1)	Decentralized (1)	Configurable (1)
Closed (0)	Coupled (0)	Centralized (0)	Not-configurable (0)

Fig. 1. The potentiality measurement

3.2 Metrics for compatibility measures

The compatibility measures are performed against the barriers to interoperability. The following shows an example of compatibility measures:

The conceptual compatibility:

- *syntactic compatibility*: does the information to be exchanged be expressed with the same syntax?: fully (1), no (0)
- *semantic compatibility*: does the information to be exchanged have the same semantics?: fully (1), no (0)

The technological compatibility:

- *Platform technology*: Are the IT platform technology compatible?: fully (1), no (0)
- *Software technology*: Are the software languages are compatible?: fully (1), no (0)

The organisational compatibility:

- *Authority/responsibility*: Are authorities/responsibilities clearly defined at the two sides?: fully (1), no (0)
- *Organisation structure*: Are the organisation structures compatible (ex. Hierarchical vs. network structures)?: yes (1), no (0)

3.3 Metrics for performance measures

The performance measures are concerned with the exchange of information and use information exchanged. For example, concerning the exchange of information:

Cost of exchange:

$$Cc_{ex} = \left(c_{th} - c_{mea}\right) \Big/ c_{th} \quad . \tag{1}$$

With: c_{th}: theoretic cost = the expected cost of the exchange,
c_{mea}: measured cost = the real cost of the exchange.

Time (duration) of the exchange:

$$Ct_{ex} = \left(t_{th} - t_{mea}\right) / t_{th} \quad . \tag{2}$$

With: t_{th}: theoretic time = the expected duration of the exchange,
t_{mea}: measured time = the real duration of the exchange.

Quality of the exchange:

$$Cq_{ex} = n_{succ} / n_{tot} \quad . \tag{3}$$

With: n_{succ} = number of exchange that succeeded,
n_{tot} = total number of exchange.

As far as the use of information exchanged is concerned:

Conformity:

$$Cc_{use} = n_{conf} / n_{rec} \quad . \tag{4}$$

With: n_{conf} = number of information that are conform
n_{rec} = number of information received

4 Conclusion - Discussion

This paper has presented basic concepts and metrics allowing evaluating the degree of interoperability between partners. However some points still need to be clarified. For each local coefficient, which mechanism can allow obtaining various intermediate coefficients between high and low level, without reduce the importance of one coefficient? As far as the Interoperability Degree is concerned, which means of aggregation can allow combining the local coefficients in order to obtain a global coefficient (ID)?

Another point is related to the measurement of the action resulting of the interoperation. Even if the action is outside the cycle of interoperation, does its measurement has to be taken in consideration and what is its importance to the interoperability?

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