An electronic market-place centralising exchanges in the virtual enterprise: a model proposition

Hervé MATHIEU

Institut Supérieur d'Etudes en Logistique, Université du Havre
Quai Frissard, BP 1137, 76063 Le Havre Cedex
Herve.Mathieu@univ-lehavre.fr

Abstract. In this paper, we show that Service Oriented Architectures enable exchanges to be more flexible inside the virtual enterprise (VE), because they create an electronic market-place between the actors composing the VE. However, mechanisms have to be settled to regulate exchanges inside the VE, as well as to protect the VE from external threats and aggressions. Those mechanisms can be materialized by Service Level Agreements (SLA) aiming to define criterion evaluating the quality of exchanges (products and services) inside the VE. This SLA definition is very important, because it will guarantee the good transaction operations between actors. In very specific and well-known fields, an automatic SLA creation can be considered, which would enable to perform transactions between actors in an automated way. At last, we propose a simple solution based on the auction principle to match offer and demand in the market-place.

1 Introduction and context

In a more and more globalized context where competition is hard, sometimes enterprises have to make alliances to be able to answer to a specific market. It is therefore necessary that different actors (enterprises) regroup themselves to answer to a common project. Despite obvious advantages that an inter-enterprise collaboration has to offer, to settle efficient collaboration is not obvious ([1] and [2]). An efficient collaboration means much more than to expose manufacturing processes and services to an external partner. Collaboration must promote the fact that partners integrate their resources in a mutual way, for a common gain. In such a context, it is not only necessary to master processes hazards inside the organization but also between the organisations, to guarantee the virtual organisation's consistency.

Today, global mastery of inter-organization processes is not reached yet, and interoperability problems between information systems (IS) is an effervescent field [3]. Thus, before mastering inter-organization processes, it is necessary that the different systems participating to the global process can in a first place exchange consistent informations. The concept of Service Oriented Architecture (SOA) [4] is a

great possibility for system interfacing, even if interoperability problems are beyond interfacing, as developed by Izza in [5], Zaidat in [6] and Verdanat in [7] with problems such as semantic or syntactical interoperability. Indeed, it is not only necessary to exchange informations between systems, but they also need to be consistent so that the systems can understand each other.

SOA is an interesting concept to make communication between enterprises easier [8] and this is an important step to make IS interoperable, because they will create universal interfacing between the IS components. However, in a service oriented architecture, there is an important need of regulation. Indeed, SOA will enable in the future to open a global market-place between the actors of the virtual enterprise, that is to say that each actor will be able to have contracts with other actors about supply and offer. There are several problems bounded to the exchanges liberalisation between the virtual enterprise actors. First of all, there is an obvious problem concerning the intellectual property as showed by Benali [9] and Panetto [10]. It is not a good thing for an actor to potentially share his know-how with his partners, because the today partners could be the tomorrow competitors. In a short term profit strategy, sharing intellectual property with no restrictions can appear as a good thing, but in a long term horizon, such a strategy is a complete disaster for the enterprise's intellectual patrimony. A second problem is that the market logic can be quite brutal, and that it is therefore necessary to regulate those exchanges between actors to avoid for example that an actor get off the VE to quickly, which could jeopardize the whole network. The contract definition regulating the agreements in the virtual enterprise is fundamental. This is this last point that we would like to develop here, the first one being the matter of executives and politicians.

In this paper, we explain why "universal" interoperability, which is potentially possible thanks to SOA is important and changes the way we handle Information Systems. Then, we explain why it is necessary to control ad-hoc exchanges between Information Systems and to design and settle regulation mechanisms managing the VE evolution. Then, we show that the exploitation of a regulation system thanks to Service Level Agreements (SLA) in the VE must be done on several decisional levels (operational, tactical, strategical), to handle the management of all informations, and to reduce the complexity of the global system. We show how an accurate SLA definition allows to improve interoperability without damaging the quality of service. At last, we propose a solution based on the auction mechanism enabling to perform exchanges of goods and services between actors of the VE.

2 IS interoperability as a keystone for the flexible virtual enterprise

2.1. Natural situation of exchanges in a virtual enterprise

When actors of a virtual enterprise want to communicate, most of the time they settle specific networks for exchanging information (figure 1).
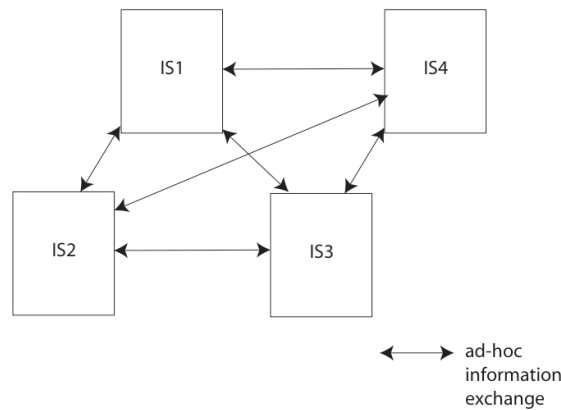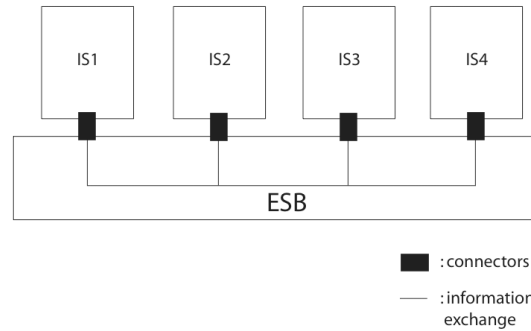
Fig. 1. Information Systems connected in an ad-hoc way

This gives as a result an ad-hoc network of exchanges, which can quickly become very complex. Such an architecture can be called a spaghetti architecture [11]. Complexity of IS architectures increases with components heterogeneity, with the more and more widespread use of Components Off the Shelf (COTS) [12], which are a today basis for current information systems. An exchange relation between ISs has to be build or destroyed specifically each time an actor enters or leaves the VE network. This presents several drawbacks such as the lack of standardization, and the lack of interoperability. Besides, if there are too many actors connected that way, the system quickly becomes unmanageable.

### 2.2   SOA enabling the inter-organization IS structuration

SOA is a logical architecture of the Information System resting on the concept of "service". The service is the basic element and the keystone of the architecture. Services Oriented Architectures (SOA) enable to better structure information exchanges between enterprises IS, which allows the actors having the will to interact to offer services which can be invoked by other actors. Besides, each entity of the VE is plugged on the enterprise service bus (ESB). SOA are very interesting when talking about virtual enterprises. SOAs offer flexibility when an actor wants to join or leave the VE. When he joins the VE, he plugs himself on the Bus and can access the proposed services. When he leaves the VE, he unplugs himself from the bus. Each actor who is present on the bus can be aware of the other's actions (thanks to a global directory), and therefore can re-configure his system. Besides, the ESB connexion can allow to create alliances more easily, the bus becomes the backbone of all exchanges, that is to say a market-place, because all the actors of the VE join it either to buy or to sell something : a service, an information, or a product.

Fig. 2. Information Systems connected thanks to an ESB

3 SOA supporting a universal market-place

We will define the concept of market-place in a simple way. For us, it is the place, real or virtual, where the offer is trying to meet the demand, at the right price (the price depends on the offer and on the demand). SOAs offer the possibility to create a market-place between all the actors of the virtual enterprise. Indeed, a seller only needs to publish what he sells, and the other actors connected on the bus are aware of it, thanks to the global directory referencing all the offered services present on the bus. In the same way, a buyer can publish what he wants to buy, so that all the actors present on the bus are aware of it. Everything can be sold or bought : goods, informations, resources.... This fact is not a revolution in the business field, but SOAs give the possibility to standardize exchanges, to make them much more easier and faster. ESBs used as market-place will lead to exchanges fluidification and standardization.
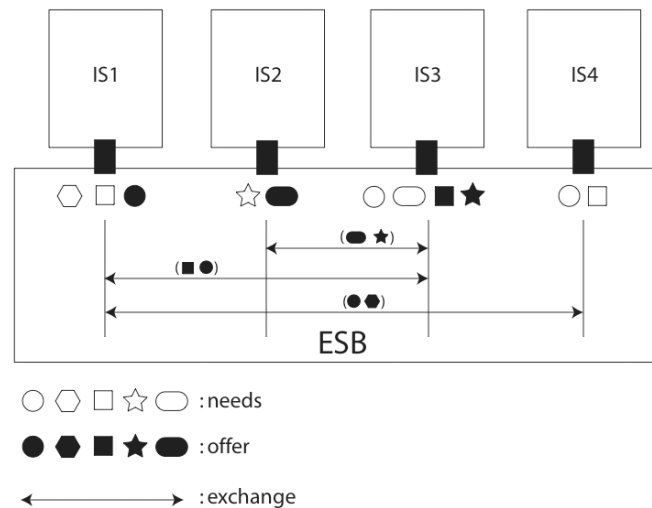
Fig. 3. Exchanges between actor's IS in the VE, thanks to an ESB

3.1 Model limits

SOA should enable to standardize exchanges of all kind between the actors of the virtual enterprise. However, these electronic market-places inside the VE will regroup any kind of goods or services to sell: available room in a transportation mean, production resources, human resources, products... There is a need, to use SOA and ESBs as a market-place, to establish a framework for exchanges, to determine what are the criterion which will establish the price of something to sell (product quality, delivery time...). SOA enable to exploit all the enterprise's patrimony.

3.2 On the obligation to regulate

We have seen in the former section that there is a need of standardization about the criterion characterizing the goods in order to simplify the exchanges. But there is also a need of regulation of relations inside the virtual enterprise.

The EV construction happens because of a specific need, which represents a market-logic and it is necessary to settle regulation mechanisms. Indeed, it is not good for the VE's operation that an actor leaves the virtual network too quickly, because such a behavior can jeopardize the whole network. In the same way, a virtual network can not accept any kind of actor, especially if he does not offer satisfying guarantees. We think that it would be relevant to settle Service Level Agreement (SLA) between actors of the virtual enterprise, to regulate the network modifications e.g. to stop brutal withdrawals or unexpected connections to the bus. Besides, SLA would enable to standardize the belonging criterion to the VE, to protect it from aggressions coming from external competitors. In some way, SLA enable to settle "solidarity" rules

between VE's actors, and offer guarantees of sustainability of the VE configuration, even if flexibility possibilities are still present.
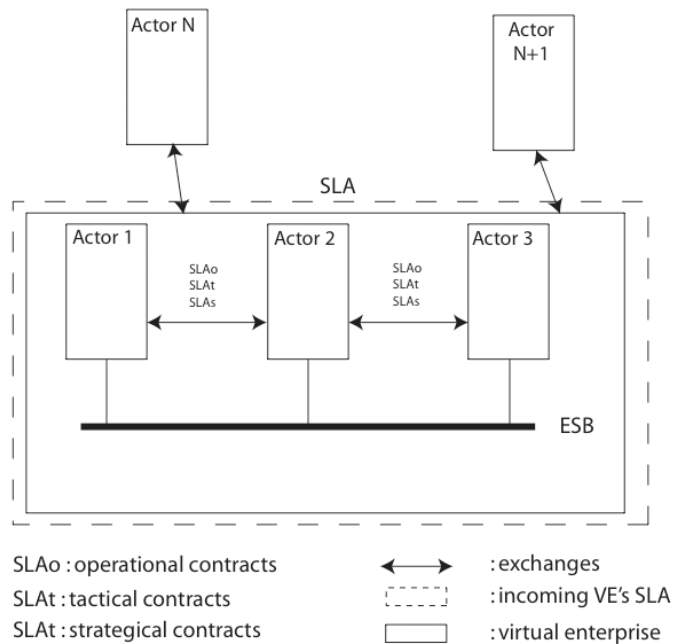
Fig. 4. SLAs as an interface for exchanges between internal and external actors in the VE

To summarize, regulation is based on exchanges criterion standardization between the VE's actors. On the other hand, it is based on contracts (SLA) inside the network, which enable to cope with difficult cases (for example brutal withdrawal) which could endanger the virtual enterprise.

3.3   Toward an automation of SLA definition to speed-up exchanges between actors ?

We can notice that if the field in which the exchanges take place is quite well-known, and if the indicators characterizing the good system operations are also well-known and are reliable, then it is possible to generate service contracts in an automated way, by using templates for example. This is of great interest in a more and more competitive environment where the rapid definition and construction of virtual enterprises will determine the actor's survival. In this case, SOA would enable to perform automatic trading of resources or services between actors. However, it is

important to notice that it will only be possible in standardized fields, and this method will not be able to be generalized to the whole enterprise.

4   A solution proposal to perform exchanges between actors

4.1 The stockbroker *vs* the auction mechanism

We assume here that the exchanges criteria between actors are standardized. Then, we need to find solutions to match the offer and the demand which exist on the bus. On a classical market-place, the price of the offer is defined by stockbrokers in function of the state of the offer and of the demand. If the demand is high and the offer is weak, prices explode, whereas if the offer is important and the demand low, they crash. In our opinion, such a market-place mechanism is not adapted to regulate exchanges in Service Oriented Architectures. Thus, classical market-places are built to exchange goods (stock or derived products) in huge amount, those exchanges being very quick. In our case, we will rather try to establish long-term trust relationships between actors of the distributed system, even if these relations should evolve considering the market state. Besides, we must not forget that behind a transaction, there are people who will work together or stop working together, and it is important that a trust relationship exist between these actors, in both case of union or separation.

The auction mechanism seems to us more adapted to our situation, because the time scale of auctions is closer from the "human" time scale which is necessary to the good operation of collaborations. The auction fully imply actors offering and demanding. This a bilateral relationship, closer to a collaborative aspect than in a classical market place where the first arrived is the first served. Auctions privilege competition, whereas each actor has his own chance. Each transaction in our system would be evaluated by both the offering and demanding sides, as on Ebay.com. In this manner, a bad actor would exclude himself of the network, because the other actors would not work with him anymore because of his bad evaluations.

4.2   Imperfections and possible improvements of the auction mechanism

The mechanism of evaluated auctions is not perfect. It is thus possible for a group of partners to create collusions, for example by leaving plenty of good evaluations to each others concerning low importance transactions, which will attract other actors, because of the positive general feedback. This would break the fact that the evaluation system is impartial, and the evaluation system is interesting only if it is neutral. To avoid that kind of problem, we could anonymise the actors participating to all the transactions, that is to say that an actor would not know with who he is dealing with. He would only know its "partners" evaluations and the services or goods they are proposing, and nothing else. Thus, when a transaction is ending, actors leave an

evaluation only according to the transaction's quality. To do so, we could settle a special service in charge of anonymising all the actors participating to transactions.

The auction mechanism can be interesting to help to settle collaborations which will be afterwards regulated by SLAs, which are in charge of normalizing the collaboration, and avoiding accidents.

5 Conclusion and perspectives

We have seen in this paper that SOA will enable to create electronic market-places between the virtual enterprise's actors, this will increase the exchanges flexibility. However, this fluidity should be handled with care, and it is necessary to settle regulation mechanisms, between the enterprise's actors, but also between the virtual enterprise and the "external world". This regulation, which can be formalized thanks to Service Level Agreements, aims on one hand to bring more clarification in exchanges, and on the other hand to protect the virtual enterprise from aggressions coming from external competitors.

Service Level Agreements are fundamental for exchanges regulation in the virtual enterprise, but they should not interfere with the exchanges fluidity generated by SOAs. For well-known fields in the enterprise, it could be possible to generate contracts automatically, thanks to reliable indicators, which would enable to perform some transactions automatically between actors. To establish the indicators enabling to elaborate service level agreements is a huge task which needs to be handled very carefully. Indeed, indicators will vary from a field to another, but it will be necessary to take into account the miscellaneous horizons when designing the contracts (operational, tactical, strategical). Besides, if the contracts are here to regulate the exchanges, they play a fundamental evaluation role between actors, and this will enable to promote actors offering good products or services in the virtual enterprise, and on the contrary to penalize the actors who are not that efficient. An auction mechanism can be used to match the offer and the demand. In this context, auctions seem more adapted to us than a classical market-place mechanism where that is the stockbroker who matches the demand with the offer and defines the prices. An important work must be done to settle evaluation mechanisms, to prevent or to stop fraud and collusion attempts between actors, to be able to guarantee exchanges integrity, and thus to ensure the survival and the good operation of the virtual enterprise.

6 Bibliography

1. Bremer C.F., Mundim A.P.F., Michilini F.V.S., Siqueira J.E.M., Ortega L.M.: « A Brazilian case of VE coordination », Proceedings of the PRODNET Working Conference on Infrastructures for Virtual Enterprises, p. 377-386, Kluwer Academic Publishers (1999)
2. Wildeman L., Stoffelen R.: Alliances and networks of the next generation. KPMG Alliances Networks & Virtual Organisations. K. report. Amsterdam, The Netherlands (1996)

3. Touzi J.: Hints for collaborative Information System conception, and for enterprises interoperability (in french), PhD Thesis, Ecole des Mines d'Albi, France, 248 pages (2007)
4. Chappell D.: Enterprise Service Bus, O'Reilly Media, 352 pages (2004)
5. Izza S.: Industrial infomation systems integration, a flexible approach based on semantical services (in french), PhD Thesis, Ecole des Mines de Saint Etienne, France, 390 pages (2006)
6. Zaidat A.: Engineering specification framework for networked organizations (in french), PhD Thesis, Ecole des Mines de Saint-Etienne, France, 258 pages (2005)
7. Vernadat F.: « Interoperable enterprise systems : architecture and methods », INCOM 2006, Saint Etienne, p. 13-20 (2006)
8. Monfort V., Goudeau S.: Web services and Information System operability (in french), Collection InfoPro, Collection Dunod / Informatique (2004)
9. Benali K.: Some basic bricks and concepts for cooperation and cooperative systems (in french), PhD Thesis, Nancy University, France, 189 pages (2004)
10. Panetto H.: Meta-Models and Models for integration and interoperability for Enterprise Production Applications (in french), PhD Thesis, Nancy University, France (2006)
11. CCPace, 10 keys to fixing and avoiding « spaghetti » architecture. Technical report, www.ccpace.com/Resources/documents/Spaghetti_Architecture.pdf, 12 pages (2006)
12. Boehm B., Abts C.: « COTS Integration: Plug and Play ? », IEEE Computer, Vol. 32 n°1, p. 135-138 (1999)