Interoperation Evaluation Framework
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Thomas Keller
Reinhard Riedl
Thomas Marko

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Thomas Keller [1], Reinhard Riedl [2], Thomas Marko [3]

[1] *University of applied Sciences, Zurich, Switzerland, kth@zhwin.ch*

[2] *University of applied Sciences, Bern, Switzerland, reinhard.riedl@bfh.ch*

[3] *bint GmbH, Winterthur, Switzerland, thomas.marko@bint.ch*

Abstract

Information and Communication Technology (ICT) is a key enabler for automating and optimizing process execution in process integration projects. Traditionally, business integration has a medium to long term horizon. However, with the introduction of the concepts of the Virtual Organisation and the Extended Enterprise this horizon is coming closer with the implication that business integration doesn't pay off anymore. In order to overcome this new challenge semantics are applied to existing integration technologies. This leads to a new flexibility and hence to new opportunities for the trade-off of higher complexity. To handle this increased complexity and to manage the decision process new means to evaluate the economic business potential are required. This paper presents the interoperation evaluation framework (IEF) as an analysis tool for this purpose.

1 Introduction

In an effort to gain both economic benefits and competitive advantages, companies and public institutions are increasingly involved in ever more complex networks of cooperation. The level of cooperation varies from simple exchange of information to complex interactions of processes. Process integration across functional borders and across enterprises is increasingly supported by business information technology. Alongside this development, proprietary processes are being replaced by standardized processes or are standardized themselves, leading to a situation where processes become commodities [Davenport, 2005]. This opens new possibilities with regard to simplified process composition and orchestration. Hence, in the future, each link in the value chain will be a standardized and interchangable process.

Traditionally, networks of enterprises had a mid to long term duration. Today, short term networks are becoming more and more important as well; they can be adapted to the needs of the individual project, they are more flexible and efficient. This is especially true for virtual enterprises since cooperations may be setup on a project by project basis, striving after the optimal allocation of resources. This new focus on short term cooperations has a significant impact on the business information technology infrastructure [Ader]. The investment in process automization merely for short term cooperations does not pay off very well. Even for value chain networks where application heterogenity is low, a considerable amount of resources must be invested in automizing processes. With a typical pay-off period of longer than three years, short term cooperations are a real challenge.

In order to overcome this dilemma a recent approach in business information technology is to extend current technologies by semantics. If the cooperation-partners' application interfaces are made self-describing enough to enable automated process composition, the cost of automization will decrease to a level where it pays off even for short term networking. Probably the best-known area used for this approach is semantic web services [Sivashanmugam, 2003] and automated process interoperation based on a service-oriented architecture [Milanovic, 2004]. The ultimate goal is process composition based on semantic information which can theoretically be fully automated. Research activities are intense in this field and are mostly concentrating on a purely technical view. However, to reach this goal the complex business aspects of the enterpreneurial (strategic-structural) level need to be considered for the support of short term collaboration networks. A common understanding in an Industry is mostly reflected by the quantity of relevant work on reference processes (or metaprocesses) describing solutions. Examples can be found in, e.g., the supply chain or in the insurance industry. This work is typically tedious and needs a lot of time and resources [Hepp, 2007]. Most important, the responsibility is on business and not on IT.

The alignment of processes within a network of enterprises along value chains (in addition to the automization of this alignment) has various influences on the enterprise itself, but also on the network as whole. The first factor to consider is definitely the strategy that the enterprise has defined or is willing to follow. But the structure and culture of the enterprise will also have an influence. Other factors that may have an impact are for instance legal issues and how the costs and benefits are shared among the partners [Hepp, 2007].

It is not obvious what strategic-structural and technical circumstances may be necessary to justify automated process composition. A business case must promise a real advantage over a traditional business integration approach where business systems are integrated manually. The following questions need to be addressed:

- What possible added economic value can be achieved within the given enterpreneurial constraints?
- What are the determinants of a successful implementation?
- What criteria have to be monitored?

If the enterpreneurial constraints are not given and open for change, the first question from above can be reversed and a second question added:

- Is my enterprise fit for automated process composition?
- What measures have to be taken to enable added economic value?

Only a well structured and comprehensible business case will attract investment in such a high risk development. Without serious investment automated process composition cannot readily be boosted to an industrial scale.

A conceptual framework that attempts to answer the above questions is presented below.

2 Relation to Existing Theories and Work

In the past many of the big suppliers of integration solutions have proposed approaches to business process integration, orchestration or choreography models in order to illustrate complex and stateful interactions between Web Services. They include business process markup language (BPML), business process specification schema (BPSS), Web Service choreography language (WSCL), Web Service flow language (WSFL), Web Service choreography interface (WSCI), Web Service Architecture (WSA), XLANG and the successor of XLANG and WSFL: BPEL4WS [BPEL4WS, 2003]. However it appears that these technologies alone cannot reach the target of self-organized interoperation among Web Services [Mandell, McIlraith, 2003].

Parallel to the development in the Web Services field, languages and tools were developed in the Semantic Web field in order to make the content of Web pages machine-interpretable with the intention of automizing as many Web tasks as possible. In the course of this development, languages arose like the Resource Description Framework or RDF [Lassila, Swick, 1999], RDF(S) [Fikes, McGuinness, 2001], DAML+OIL, which is now named Ontology Web Language (OWL) [Antoniou/Harmelen, 2003]. An ontology Web Service was developed based on OWL and called OWL-S [OWL-S]. Additionally there is the Web Service Modelling Ontology (WSMO) [Brujin et al, 2005] and the latest standard is the Semantic Web Services Framework (SWSF) [Battle et al, 2005]. A short overview is shown in following table [Keller, 2005].

	OWL-S	*WSMO*	*SWSF*	*WSDL-S*
Scope	Description model for semantically describing Web services	Description model & language for core elements of Semantic Web service technologies	Extension of the OWL-S Process Model	Semantic annotation of WSDL descriptions
Top Level Elements	Service Profile, Process Model, Grounding	Ontologies, Goals, Web Services, Mediators	Processes	Operations / WSDL descriptions
Service Level Description	Non-functional aspects IOPE for service-level functional descriptions	Capability (PAPE) for provided and requested functionality	Not in the scope	Keyword classification (ontology-based)
Operation Level Description	IOPE for processes	Interfaces for consumption (choreography) and interaction (orchestration)	Internal behavior (atomic and composite processes)	Preconditions & effects for WSDL operations
Language (static)	OWL	WSML	SWSLFOL & SWSLRules	Not specified
Language (dynamic)	Process Model and OWL	Abstract State Machines	FLOWS	Not specified

3 Research Approach

The "Interoperation Evaluation Framework (IEF)" has its roots in well established management frameworks [Rühli, 1996], [Rüegg-Stürm, 2003], [Bach, 2002], [Joyce, Nohria, Roberson, 2004] which consider strategy, culture, structure and their relationships as views of an enterprise. These views are complemented by additional process and information oriented views as shown in Figure 1.

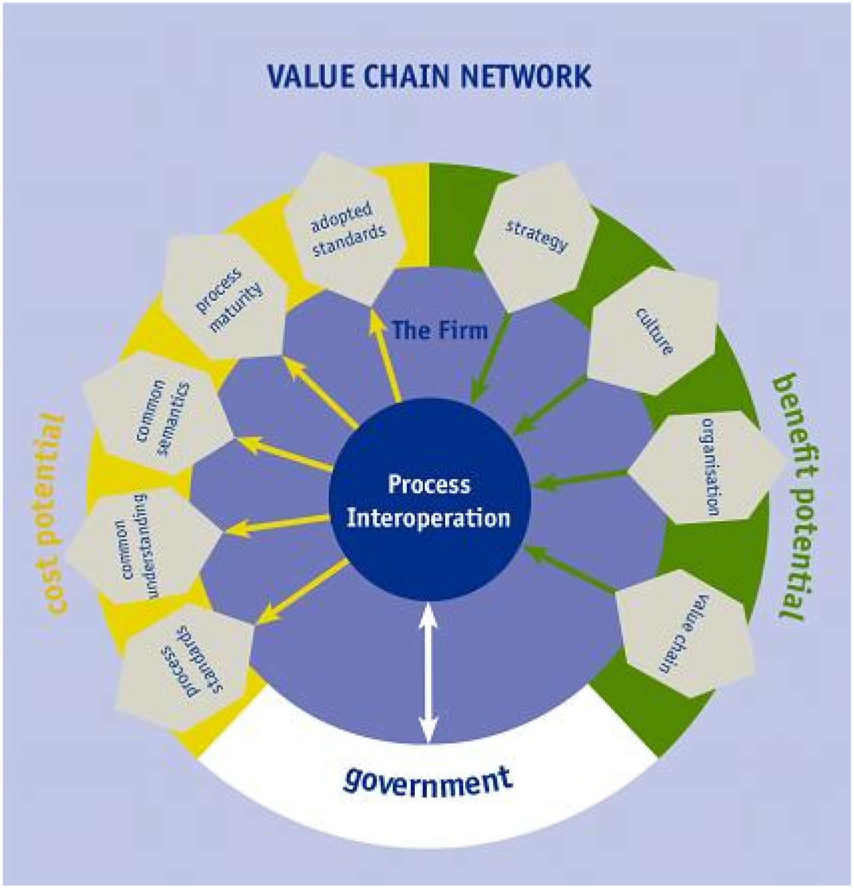

Figure 1: Overview of the Interoperation Evaluation Framework (IEF)

Each view is composed of a set of aspects or criteria by which we can analyse the particular context where the framework is applied. The aspects have been theoretically derived from existing research and logically deducted based on the nature of automated interoperation.

Due to the complexity and the multi-layered nature of automated interoperation, it is not easy to understand the topic in its entirety. This is why it is important to create a conceptual frame by means of which basic interconnections as well as some principles can be shown systematically [Anthony, 1988].

Thus, a framework clarifies the research object and can serve as a basis for scientific objectives and research perspectives. Existing theories, or at least hypotheses derived from such theories, are used as a foundation. This fact must be reflected in the design elements and measures inherent in the framework.

Due to the fact that the context of this framework is subject to intensive research, the framework is also going to be used to position and classify new findings, trends and methods. The framework is therefore also a structuring and classification instrument.

In the context of corporate management, the framework is going to provide a coordinating and integrating function, which makes it easier to communicate complex issues and assess the implementation of leadership decisions. It acts as a conceptual screen with which to evaluate both existing and newly developed problem-solving methods.

In the modern philosophy of science, frameworks constitute the basis for both empirical-inductive as well as analytical-deductive research [Rühli, 1996]. In the inductive method, a great number of observations can be deduced from generalizable findings. They are then integrated into a single conceptual frame. The quality of the framework that is thus generated very much depends on the objectivity of the observations. These can, in turn, be affected by the value-generating network(s), the industry, the current economic situation or the spirit of the age. The deductive method starts with existing, superordinate phenomena and circumstances which have been accepted by virtue of their logic and plausibility. The quality of a framework that is deduced in this manner is directly dependant on how closely the superordinate circumstances and the logic of the deduction approach reality. The evaluation framework described below is based on the deductive method.

The different views and their individual aspects have been validated by interviews and in a second step have been applied in the healthcare and medical industries. The results were promising. All views and their aspects could have been validated and ranked according to their importance. The ranking will most probably be industry specific and has the effect of prioritizing views and their related aspects. This enables the adoption of the framework in different contexts.

4 Findings

Automated interoperation has an impact on the whole enterprise and its value chain network starting from strategic questions and ending with the needed technical infrastructure. Since the questions are tightly interrelated, rather new and not well structured, the interoperation evaluation framework helped to structure the problem and to set a common understanding about the problem area itself. It enabled a discussion based on the same conceptual basis for all stakeholders which is an important fact since automated interoperation must be a joint effort otherwise it will fail. Figure 2 shows an overview of the strategic-structural part of the framework. The four views strategy, organisation, culture and value chain are shown with their respective aspects. The validation has shown that these four views do realistically express the influence of automated interoperation on the enterprise and vice versa. There was also a general agreement on the choice of the various aspects. However, more validations of the framework are needed, particularly in a more diverse range of contexts. Open questions remain, such as context-dependent weighting of the different aspects, and a reasonable operationalisation for practicability.

4.1 Benefit vs Cost Potential

The framework stipulates that the strategic-structural views determine the possible benefit potential indepently from any technical constraints. On the contrary, the technical views are assumed to determine the cost potential associated with automated interoperation. This stipulation was generally accepted if automated interoperation is implemented in a given entrepreneurial context. However, as soon as strategic-structural changes are planned in order to adapt the enterprise to automated interoperation, the above stipulation can not hold anymore. The arrows for the strategic-structural views in Figure 1 would be reversed or double-sided.

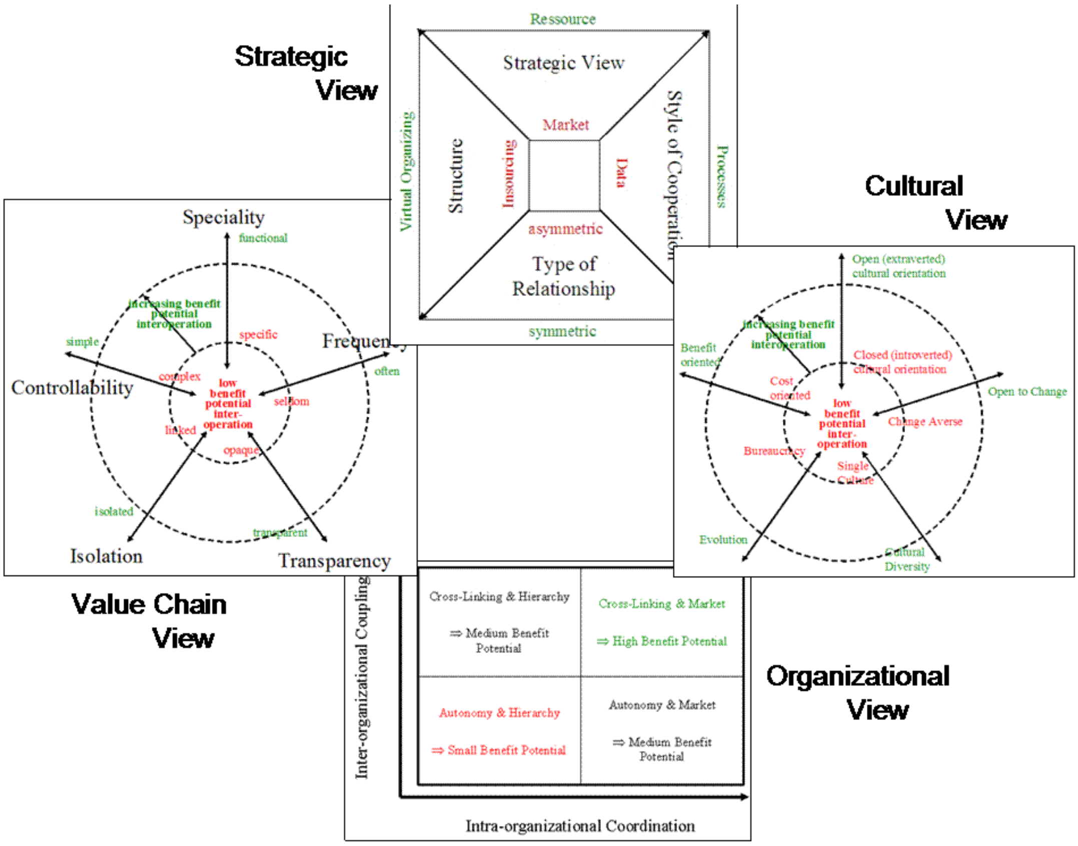

Figure 2: Overview of the four strategic-structural views and their aspects.

4.2 The Value Chain Network

As previously mentioned, the value chain network plays an important role for automated process composition. Two basic cases can be distinguished as shown in Figure 3. The first case consists of a network that is relatively better suited for automated process composition than the enterprise under investigation (Scenario 1). The other case (Scenario 2) is the contrary: the enterprise is relatively better suited than the network. The latter case has a serious drawback in that the enterprise must be able to gear the whole network up to a suitable level for process composition. This will be possible only in those rare situations where the enterprise has enough market power. The first case is much easier. The enterprise simply copies best practices from the network. However, copying best practices from other application domains tend to be difficult.

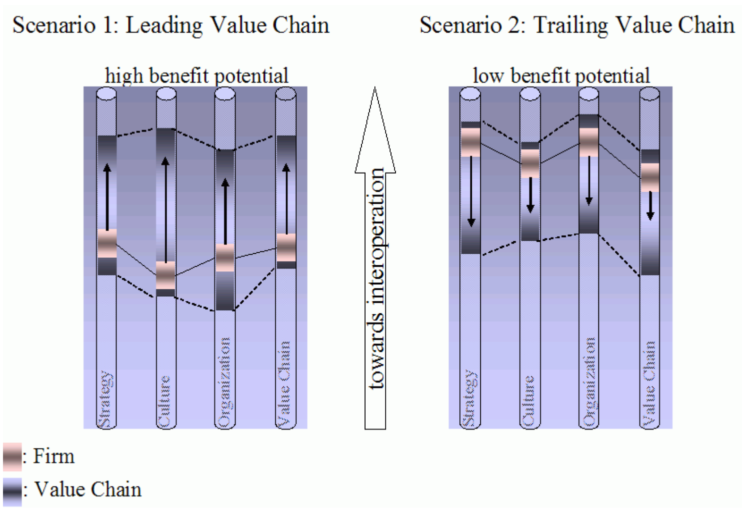

Figure 3: Alignment of the value chain network shown as two scenarios

4.3 Framework Application

The framework presented above in Figure 1 has been applied to two different industries. In the healthcare industry several hospitals in Switzerland have been investigated and characterized. In the medical industry a conglomerate of enterprises in the South of Germany has been investigated. The research question was whether automated process composition would be applicable and under what conditions it would lead to further improvements in the cross-linking of the various processes. Following some findings based on the latter case:

- The investigated conglomerate features a shared quality management. This has led to shared and common processes which are partly automated. The application landscape in the different enterprises is rather homogeneous due to the central management. The products and services available and offered by the various enterprises are catalogued and classified by a shared classification scheme according to UNSPSC. The governmental influence is limited. In short, decision-making is relatively straightforward.
- Strategic analysis shows a medium to high benefit potential because within the conglomerate a resource based view is applied, combined with outsourcing of non core competencies. In certain cases the level of cooperation approaches virtual organization. Within the conglomerate the type of relationship is symmetric, with external partners rather asymmetric, showing the market power of the conglomerate.
- The culture and the organization are both suitable for automated process composition. This is definitely the result of the internal structure of the conglomerate. The value chain consists mostly of processes that are frequently used. They are transparent, modular, partly isolated and range from specific to functional; all features which lend themselves to the application of automated process composition. The overall benefit potential is medium to high.
- Meanwhile, the cost potential is low to medium. Due to the centralized quality management, common semantics and common problem-understandings exist already. In addition, the governmental influence forces a common problem understanding by enforcing certain regulations. Process standards are defined and applied due to the quality management. Process maturity has reached the level of automization. In certain cases processes are modular and ready for interoperation. The applied standards vary depending on the enterprise. There are some standards that are used on conglomerate level which are forced upon all enterprises. Only this last point increases the cost potential; all the other technical aspects suggest low cost potential.
- Both the benefit potential as well as the cost potential are in favor of automated process composition. The conglomerate is a good business case for automated process composition.

As for the healthcare industry, the framework has already proved to be a valuable tool in analysing the situation. The results can be used for argumentation and communication with the various stakeholders. Attracting and convincing business sponsors is getting easier.

5 Conclusion

Obviously the idea of the Extended Enterprise in conjunction with Business Information Technology lies far in the future for most enterprises. The majority of interview partners responded with interest but made it clear that the problems with today’s integration solutions have not been solved yet. The many constraints and the high level of semantic understanding needed for a working prototype is too high a risk, especially considering the fact that the respective standards have not yet reached a sufficient level of acceptance in any Industry.

Automated interoperation and process composition is a field which promises to make the value chains of cooperation partners flexible and thus viable for short-term cooperations. However, the impact of such an approach is complex. First the strategy of the enterprise must be suitable, the organisational structure must fit and of course the culture of the enterprise and of the whole network must allow for flexible processes. Second, not every process (e.g., service, product) is suited for flexibility in the sense that it shows an economic added value. And third, presence or absence of the needed semantics is very often the make-or-break criterion for a successful project. There are more critical factors to consider on the technical level like suitable standards.

Since the complexity of an automated approach to process composition is high, it is helpful to have a conceptual framework which structures the problem area and serves as a basis for a common problem-understanding. This common problem understanding is even more important since interoperation implies cooperation amongst enterprises. The interoperation evaluation framework has proved very helpful in this regard. It is used furthermore to assess the enterprise and its value chain network, and it identifies problem areas which have to be solved in order to reach the ultimate goal of automated interoperation.

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