Towards a Framework for Inter-Enterprise Architecture to Boost Collaborative Networks

Alix Vargas[1], Andrés Boza[2], Llanos Cuenca[3] and Angel Ortiz[4]

Centro de Investigación en Gestión e Ingeniería de Producción (CIGIP),
Universitat Politècnica de València, Camino de Vera s/n Ed 8G -1º y 4º planta Acc D,
[1]alvarlo@posgrado.upv.es, {[2]aboza, [3]llcuenca, [4]aortiz}@cigip.upv.es

Abstract. A complete Inter-Enterprise Architecture should be conformed to a framework, a methodology and a modelling language. In this sense, this paper proposes an initial Framework for Inter-Enterprise Architecture (FIEA), which organizes, stores, classifies and communicates in a conceptual level the elements of the Inter-Enterprise Architecture (IEA) and their relationships, ensuring their consistency and integrity. This FIEA provides a clear picture about the elements and perspectives that make up the collaborative network and their inter-relationships, supported for technology base on the Internet for its inter-operation.

Keywords: Inter-Enterprise Architecture, Framework, Supply Chain, Collaborative Networks, Future Internet

1 Introduction

The current environment of globalization and competition directs the flow of business through the supply chain (SC) or, more recently, collaborative networks (CN), since companies cannot compete individually. Therefore, it is necessary that the companies that comprise these SCs or CNs are integrated and coordinating their processes to become more competitive and efficient, thus enabling the fulfilment of the overall objectives of the CN and its own objectives. On the other hand, organizations are more complex now and require flexible business processes that are supported by an efficient information technology (IT) infrastructure. It is undisputed that IT and information systems (IS) have become strategic functional entities within organizations, and these functions have an increasing impact on business strategy, because IS/IT currently constitute a competitive advantage for organizations to be sustainable over time. In this sense, companies should be managing the increasing technological complexities accrued while they generate added value to business processes, and at the same time achieve integration and coordinate their processes with their partners in the CN in the pursuit of efficiency and competitiveness to ensure survival in the global market. Achieving these goals may be possible using Enterprise Engineering (EE) with an Enterprise Architecture (EA) approach [1].

The concept of Inter-Enterprise Architecture (IEA) has been proposed using the tools and methodologies of EA for individual enterprises, but adapting them in a

collaboratively networked environment between several enterprises that make up SCs and CNs. This will facilitate the collaborative processes of integration between enterprises with their information systems and technology systems, supporting joint processes, reducing risks and redundancies, increasing customer service and responsiveness, reducing technology costs and allowing for alignment on multiple levels [2]. CNs can allow small and medium enterprises (SMEs) to share information through the use of IT in support of their business processes. If a CN is accurately created and managed, this allows SMEs to make being part of the CN more competitive, creating added value in their own business, enabling innovation and boosting learning and knowledge. In the context of CNs, two important approaches will be taken into account in the development of the proposal framework: Virtual Breeding Environments [3] and Digital Business Ecosystems [4]. The Internet has become a necessity in business environments, but many SMEs cannot afford to use it as a management and operational tool due to cost, availability and trust. In order for the Internet to become useful as a real universal business system used by a CN, it is necessary to branch joint efforts among society, government, research and industry. Following the ideas of the FInES Cluster [5], the Framework for Inter-Enterprise Architecture (FIEA) is based on the use of Internet as technology that enables the interoperation between enterprises that form a CN.

Taking into account the blueprint of the newly networked enterprise environment, the paper is structured as follows: Section 2 describes the related work in these fields; Section 3 presents a proposal of FIEA; Section 4 presents the main conclusions and future steps.

2. Research Topics

2.1. Strategic Alignment

According to [6], strategic alignment is: "A dynamic and continuous process that enables integration, adjustment, consistency, understanding, synchronization and support between business and Information Systems/Information Technology (IS/IT), in order to contribute and maintain the correct performance of the organization, creating a competitive advantage that is sustained over time". It is clear that SCs and CNs have to be able to manage the technological complexities of their IS, while ensuring that these generate added value to business processes. This can only be achieved if there is an alignment between business and IS / IT, and this concept became stronger in the 1990s thanks to the Strategic Alignment Model (SAM) proposed by [7]. Although the theory suggests that there should be a strategic fit and functional integration between business and IT, in reality, the implementation of the alignment is quite complicated to carry out, because the studies, models and/or frameworks developed for this purpose are scarce and their utility is often not validated in the real world. However, this strategic alignment can be achieved through the use of enterprise architectures (EA) [8].

2.2. Enterprise Engineering and Enterprise Architecture

Enterprise Engineering (EE) is the discipline applied to carrying out any efforts to establish, modify, or reorganize any enterprise [8]. This discipline is responsible for defining, structuring, designing and implementing enterprise operations as communication networks of business processes, which comprise all their related business knowledge, operational information, resources and organization relationships [9]. The field of EE is concerned with understanding, defining, designing and redesigning business entities, which includes all knowledge and organizational relationships, as well as life cycles [10]. Therefore, EE facilitates the integration of all elements of the enterprise. Enterprise Integration (EI) deals with facilitating information flows, systems interoperability and knowledge sharing among any kind of organization [11]. Achieving EI through the EE is possible thanks to the use of (EA). In [12], taking into account ancient definitions, EA is defined as: "A discipline that provides a set of principles, methods, models and tools used for analysis, design and redesign of a company, thus allowing to represent and document the elements that form the company (such as organizational structure, business processes, systems information and technology infrastructure) and the relations, organization and joints between these elements, allowing the company to be represented in a holistic and integrated perspective, in order to achieve the business objectives and facilitate decision-making processes". The main elements of EA are: methodology, framework and modelling language [12]. These elements must be provided by EA for successful implementation within the enterprise. The methodology defines how the EA will be implemented and how it will develop, use and archive the documentation. The framework allows for structuring of the elements of the EA and their relationships in a graphical and simple way, taking into account different views or perspectives and the life cycle phases. Finally, the identification of a modelling language allows modelling and understanding the relationship between the views that make the company, in a structured way.

2.3. Enterprise Collaboration

Enterprises today do not compete individually, and now the SCs and/or CNs compete with each other in search of increased profits and generating more customer value. Therefore, the necessity of a high degree of integration between partners that make up these SCs or networks is imminent [13], and this degree of integration may be achieved through collaborative mechanisms to ensure the alignment of individual plans in the search for achieving a goal of a joint plan. Thus, enterprise collaboration emerges as a tool that allows members of the SC and CN to be making decisions together, based on shared information and the exchange of a bilateral form, which allows them to coordinate and synchronize activities with the objective of satisfying the market and increasing joint profits [12]. Base on the main elements provided for several authors we propose the definition of enterprise collaboration process in [12], as: "A joint process between members of the SC, where the decisions are made jointly, based on the information shared and exchanged on a bilateral form, achieving

coordinate and synchronize joint activities to meet customer requirements and achieve process efficiency sets to generate a mutually beneficial"

2.4. Collaborative networks

In the new market environment, enterprises have to deal with the complexity of contemporary products, new customer requirements, geographically distributed partners, and a constantly changing technological environment. This is a big challenge that must be approached delicately, especially by SMEs that do not have the resources (both monetary and skilled workforce) and simply-used and affordable IT solutions to face this challenge by themselves. Therefore, SMEs have to make up CNs in order to be competitive and survive this turbulent environment. According to [14] "CN is a network consisting of a variety of entities (e.g. organizations, people, machines) that are largely autonomous, geographically distributed, and heterogeneous in terms of their operating environment, culture, social capital and goals, but that collaborate to better achieve common or compatible goals, thus jointly generating value, and whose interactions are supported by computer networks". When CNs (industry), Researcher Institutions, Universities and Governmental Organizations join efforts in order to create a community that looks for increasing industrial competitiveness, they are creating traditional "Clusters". A cluster represents an association or pool of enterprises and related supporting institutions that have both the potential and the motivation to cooperate with each other through the establishment of a long-term cooperation agreement [3]. The conceptual foundation of Clusters has given origin to two new fields: Virtual Breeding Environments (VBE) [3] and Digital Business Ecosystems (DBE) [4].

2.5. Future Internet

In the new economic environment, IT and specifically Internet are ubiquitous [15]. The rapid growth of the Internet has enhanced computing, sharing and communication capabilities, but also introduced uncertainties regarding the future of existing traditional business models. In order to sustain and increase business competitively, enterprises should embrace these new technologies carefully taking into account different vital aspects: security, agility, accuracy, interoperability, affordability and reliability. On the other hand, there are some important requirements for the implementation of IT solutions into SMEs in a context of collaboration according to [16] are: cost, time, flexibility, privacy and trust. In this sense, [5] affirms that the next decade is expected to see a thorough change in the way enterprises operate, mainly due to the advent of the Future Internet and the maturity achieved by enterprises in adopting new socio-technical solutions based on the former.

2.6. Emergent concept of Inter-Enterprise Architecture (IEA)

After a thorough analysis of the current literature in the fields summarized above, we have identified trends, studied models that have strongly related concepts and associated issues, analysed main ideas and common points, and identified a large gap in the literature, due to the fact that there is not currently any documentation tying these fields of research together. As a result of this gap, the concept of Inter-Enterprise Architecture (IEA) is proposed, searching for applications of the tools and methodologies of enterprise architecture, which have been developed for the individual enterprise, but adapting them in a collaborative environment between several enterprises that make up CNs [2]. This will facilitate the collaboration process of integration between enterprises with there IS/IT based on Internet, supporting joint processes, reducing risks and redundancies, increasing customer service and responsiveness, reducing technology costs and allowing for alignment on multiple levels. In Fig. 1, currently completed work is summarized, and the field of intended study is represented in the spotlight.
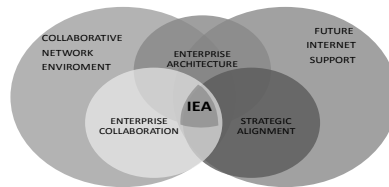

Fig. 1. Origin of IEA concept into a CN environment with supporting of future Internet

The implementation of an IEA is part of establishing a set of architectural guidelines that ensure comprehensive development between models and inter-enterprise needs, with joint business processes and IT. These guidelines will also be responsible for spawning the necessary information for the joint operation of organizations and technologies required to support joint operations and new technology implementation processes in response to ever-changing needs and jointly involved organizations. In this IEA, technology plays a definitive role, according to the concepts of DBE that consider that technology must be the medium that facilitates the formalization and distribution of the knowledge from which the same technology emerged. Essentially, technology becomes a catalyst for development of enterprises, SCs, CNs and DCs. Therefore; technology accelerates the growth and harmony of the DBE.

3 Proposal of the Framework for IEA

Three elements are necessary in any EA: Framework, Methodology and Modelling Language. In this section, we propose a framework for modelling CNs in the context of IEA (FIEA). The FIEA is defined as: "A logical structure for classifying, organizing, storing and communicating conceptual level elements or components of the IEA and their relationships, ensuring consistency and integrity. This structure defines the scope of IEA and provides a basis for assembly and development". The following surveys have been taking into account in our analysis: 1) Total Enterprise

Architecture as: CIMOSA [17], GIM-GRAI [18], GERAM [19], IE-GIP [20,21], TOGAF-ADM [22]. 2) In the context of CNs: ARCON [3], VERA [23] and ARDIN-EVEI [24]. Table 1 shows a comparative analysis of the views and life cycle phases for these surveys and in the last column are defined the modelling views and life cycle phases for FIEA.

Table 1. Comparative analysis between framework modelling perspectives of EA and CNEA

FRAMEWORK MODELLING PERSPECTIVES			ENTERPRISE ARCHITECTURES (EA)					COLLABORATIVE NETWORKS EA (CNEA)			FIEA
			CIMOSA	GIM-GRAI	GERAM	IE-GIP	TOGAF-ADM	ARCON	VERA	ARDIN-EVEI	
Modelling views	Modelling views defined in ISO 19439 (2006)	Function	=	±	=	±	±	=	=	=	*Business Process
		Information	=	=	=	=	=		=	=	*Knowledge
		Resources	=		=	=		±	=	=	=
		Organization	=		=	=		±	=		=
	Other views provided by the different architectures	Decision		▓						▓	
		Data				▓					
		Applications				▓					*IS/IT base on Internet
		Technology				▓					
		Behavioural						▓			
		Market						▓ (Exogenous interactions)			
		Support						▓			
		Societal						▓			
		Constituency						▓			
Modelling life cycle phases	Life cycle phases defined in ISO 19439 (2006)	Domain identification			=	=			=	=	2 Conceptualization*
		Concept definition		=	=	=			=		
		Requirements definition	=		=				=	=	3 Definition*
		Design specification	=	=	=				=	=	
		Implementation description	=		=	±			=	=	4 Operation*
		Domain operation		=				=	=	=	
		Decommission definition			=			±	=	=	6 Dissolution*
	Other phases provided by the different architectures	Definition business				▓					
		Creation						▓			1 =
		Evolution						▓			5 =
		Metamorphosis						▓			

Convention

	It is not included into the framework
=	It is included into the framework with the same o similar name
±	It is not included in an explicit form but it can be deduced from the context
▓	Other views provided by different architectures
*	Evolution of the view or phase
1 - 6	Sequence of the life cycle phases

Seeking to propose a useful reference framework for modelling an IEA, we propose the FIEA, of which the structure and elements are shown in the Fig. 2. Following the guidelines of previous work on enterprise architecture frameworks, we must take into account the following perspectives: modelling views, life cycle phases and modelling detail level.

Modelling views: Six modelling views have been proposed. The function view has been split into two different views: business and process, in order to facilitate the

modelling, due to the fact that the business view is focused on strategic issues and the process view is focused on tactical and operational aspects. The knowledge view is an evolution of information view. Here is a brief description of each view: **Business**: This view represents the strategic aspects that must be taken into account in the CN. **Organization**: This view allows the representation and modification of the organizational structure and the teams involved into the CN and decision-making of the CN. **Resources**: This view represents the capabilities and resources necessary to complete business processes and the roles and responsibilities of individuals and organizational units within the CN. **Process**: This view represents CN processes, functionality, performance, inputs and outputs. **Knowledge**: In the continuous learning process where organizations are involved, the information that they handle becomes knowledge which itself and its generation are elements that approaches as VBE and DBE have into account. **IT base on Internet**: This view includes technology and applications views base on the Internet that enables the interoperation among enterprises.
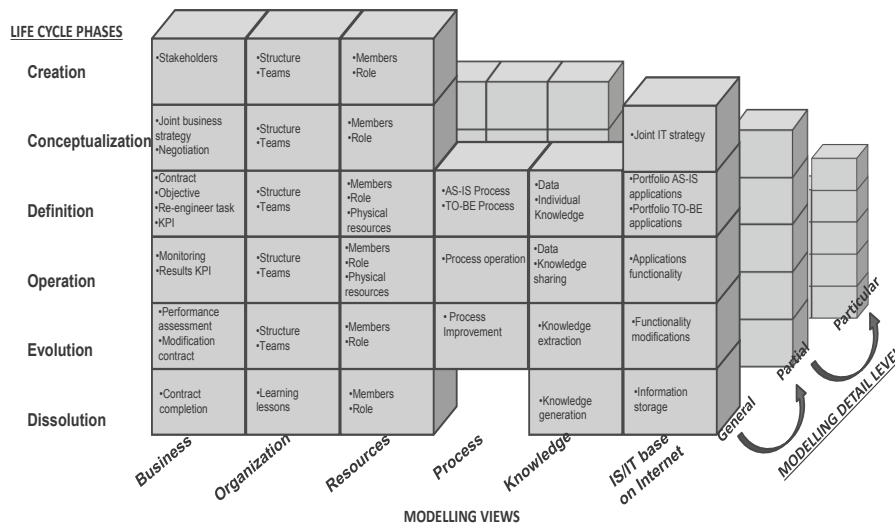

Fig. 2. Framework of Inter-Enterprise Architecture (FIEA)

Life Cycle Phases: The life cycle phases are states of development in the life cycle of the CN. FIEA considers the proposals of ARCON and GERAM in this aspect of its design, due to the fact that these two architectures complement each other. A brief description of each phase: **Creation**: This phase represents the motivation of collaboration from stakeholders into the CN and its incubation. **Conceptualization**: This phase represents the strategic definition of the CN and its implicit negotiation. **Definition**: This phase represents the definition of the elements in the CN. **Operation**: This phase is surely the most important, occuring when the CN operates directly towards achieving its goals. **Evolution**: During the operation of a CN, it may be necessary to make some changes to its membership, process, contract, structural relationships, and roles of its members. **Dissolution**: A CN will typically dissolve after accomplishing its goal.
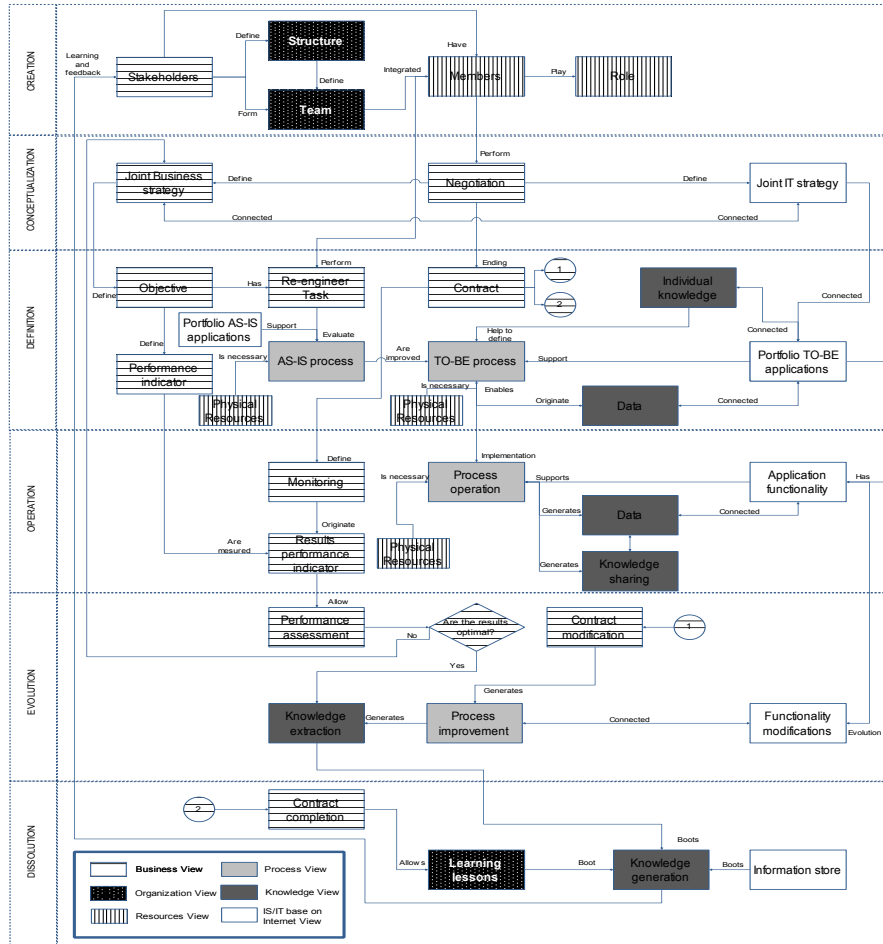
Fig. 3. Relationship Meta Model between elements views and phases of FIEA

**Modelling detail level**: This perspective has to do with the detail level into the modelling, being the general modelling the most neutral that could be used for any kind of CN, partial modelling occurs when the model is developed for a specific cluster and the particular modelling is developed for a specific CN. Each cell in the FIEA represents the intersection of a particular life cycle phase with one modelling view.

In order to validate the correct gear of the FIEA, Fig. 3 shows a Meta-Model of relationship between elements of each view in each life cycle phase, which is according to the definition of ISO 15704 [9]. This Meta-Model has helped to corroborate the right definition from the elements in each view and phase. Due to the complexity of the Meta Model and the proposal of an easy understanding of it, some elements of organization and resources views have been omitted from the model (structure, teams, members, roles), but their participation is crucial to the life cycle phases of the CN.

The main advantage of using FIEA is that it meet the necessary elements of a IEA for modelling enterprises in collaboration context, including elements that VEE and DBE

have contributed to build collaborative environments. On the other hand, these elements have associate building blocks and the content definition of them will allow modelling these systems.   In addition, the proposed meta-model ensures consistency and integrity of its elements.

4 Conclusions

An IEA should be formed for a framework, a methodology and a modelling language. In this paper, we propose the FIEA. This framework allows for having a visual model that shows the components of CN architecture with the support of Internet, covering the life cycle phases and modelling views. This paper emphasizes the need for a consistent framework for IEA in a context of collaboration, supported for the use of the Internet as a tool that enables interoperability among enterprises. The relationship Meta-Model between elements views and phases of FIEA allows validate the correct definition of the elements for each view and life cycle phase and their connection with each other. These elements and their associate building blocks will define the necessary information to modelling this kind of system. It is really important to prove the FIEA in a real-life scenario, in order to demonstrate the capability of it to support engineering projects. In future papers, we are going to continue working in this line of research in order to propose a more complete IEA supported by future internet, defining the IEA Methodology (IEAM) and choosing the modelling language to use it. Also, it is important to validate different CNs in order to propose specific and particular Architecture Models.

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