# Inter-Organisational Collaboration on the Process Layer

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**Abstract.** Today the competitive marketplaces require that the enterprises should be more flexible, innovative and responsive to their needs. Therefore, the enterprises and specially the small and medium sized ones, in order to gain a competitive advantage, should get rid of their traditional business models and adapt new ones to facilitate collaboration. This paper is a research plan aiming at a PhD degree which concentrates on dynamic collaboration between companies and in particular on the business process layer of the business cooperation framework.

## 1 Introduction

Nowadays organisations are moving or have already moved their main operations to the Web, to take advantage of the potential of more automation, efficient business processes, and global visibility. They form collaboration networks that value speed, quality and have the ability to react dynamically according to individual objectives (e.g. produce a product, provide services, outsourcing). These collaboration networks have attracted the interest of research communities but there are still many issues that need to be considered.

This paper is a research plan aiming at a PhD degree which concentrates on dynamic collaboration between companies and in particular on the business process layer of the business cooperation framework. It is thus organised as follows. In Section 2 there is an introduction on the business processes and business process management. Different types of interoperability and forms of collaboration are presented next in Section 3. In the same section, the different levels of cooperation framework are described and some research issues that arise when different companies want to interoperate are stated. In Sections 4 and Section 5 the Workflow Management Systems and Virtual Enterprises are briefly described and some of the corresponding problems are mentioned accordingly. Finally Section 6 depicts the research plan and outlines future steps that are going to be followed.

## 2 Business Processes and Business Process Management

*Business processes* are market-centred descriptions of an organisation's activities. That is, business processes are collections of activities that support critical organisational functions in realizing an objective or policy goal.

Depending on the type of participants, business processes can be classified in:

- Public processes (external), that are processes performed in collaboration with others outside the borders of the organization (e.g. suppliers in a supply chain scenario, partners in a virtual enterprise scenario and customers in a B2B scenario).
- Private processes (internal) that are performed and acknowledged only within the enterprise.

Business Processes need to be effectively managed in order to fulfil their objectives.

Business Process Management (BPM) can be defined as follows: *Supporting business processes using methods, techniques, and software to design, enact, control, and analyze operational processes involving humans, organizations, applications, documents and other sources of information* [12]. It should be noted that this definition restricts BPM to operational processes that include processes at the strategic level. This means, processes that cannot be made explicit are excluded. It is very important that systems supporting BPM need to be "process aware", i.e., without information about the operational processes at hand little support is possible.

The enterprises that advocate Business Process Management, fully control their implicit processes and they are usually aided by a universal process language like BPML, BPMN and BPEL [12] that enables partners to execute on shared vision, in order to interoperate with other enterprises, to communicate and understand each others processes in detail, to jointly design processes and manage the entire lifecycle of their business improvements initiatives.

BPM, in order to be effectively applied, needs to be supported by a Business Process Management System (BPMS). A BPMS enables companies to model, deploy, and manage mission-critical business processes that span multiple enterprise applications, corporate departments, and business partners that may be behind the firewall and over the internet. Examples of BPMS include: Tibco Staffware Process Suite [20], WebMethods Business Process Management [21], Vitria BusinessWare [22], etc. The BPMS is a new category of software and opens a new era of IT Infrastructure [1], [2].

## 3 Environmental Influences and Business Collaboration

A major part of the global economy consists of small and medium-sized enterprises. These enterprises, in order to stay competitive and survive in a rapidly changing environment, need to be part of collaborative networks of enterprises [3].Thus they need to focus on core competencies and mission-critical operations and outsource everything else.

Collaboration is defined in [9] as the agreement among a set of participants (e.g. Companies, Web services) to achieve a common goal or specified outcome in a shared process. Besides, interoperability is the ability of a system or a process to use information and/or functionality of another system or process by adhering to common standards [10].

As soon as different enterprises are able to interoperate or collaborate, they have been empowered with effective capability of mutual communication of information, proposals and commitments, requests and results. In general, interoperability covers technical, semantic and pragmatic interoperability [4]:

- Technical interoperability means that messages can be transported from one application to another.
- Semantic interoperability means that the message content becomes understood in the same way by the senders and the receivers. This may require transformations of information representation or messaging sequences.
- Finally, the pragmatic interoperability captures the willingness of partners for the actions necessary for the collaboration. The willingness to participate involves both capability of performing a requested action, and policies dictating whether the potential action is preferable for the enterprise to be involved in collaboration.

The collaboration between enterprises may have different forms:

- Collaboration based on specific standards e.g. EDI. This is a unified approach to collaboration.
- Collaboration by following an integration approach, i.e., processing platform integration, data integration, etc.
- Collaboration by joining a virtual enterprise which is usually dynamic. This means that the partners are loosely coupled and form short term partnerships. In this form of interoperability a federated approach to collaboration should be applied, that establishes and maintains collaboration between autonomous local services, each of which runs a local business process [4].

Business cooperation means that a network of companies is working together in order to deliver products and services that no-single company is able to deliver itself. This cooperation is multi-facet and should be examined regarding the following levels [5]:

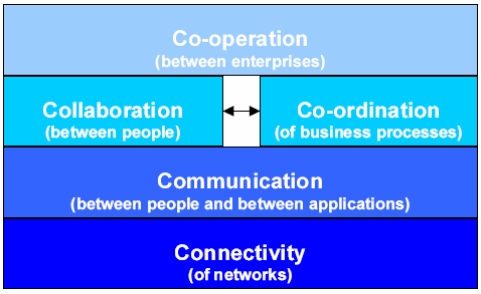

**Fig. 1.** Levels of Business Cooperation [5]

- The connectivity level, that uses protocols (e.g TCP/IP) in order for the applications of different enterprises to "talk" to each other.
- The communication layer that uses protocols and standards for communication between applications and people from the different enterprises. Application protocols, such as SMTP, HTTP, FTP and SOAP, ensure not only that people from different enterprises can communicate with each other, but that applications from different enterprises can communicate with each other as well.
- The collaboration/coordination layer that uses protocols and standards for collaboration between people and coordination of business processes. The later represents the connection of the processes of the participating companies and is the means for an effective business co-operation.
    - For the collaboration between people, IP-based solutions and standards are partly well established (e.g., SMTP for e-mail, NNTP for news, WebDAV for document sharing, H.323 and T.120 series for real-time voice and data conferencing) and are partly starting to appear (SIP for Internet Telephony, SIMPLE for Presence and Instant Messaging).
    - On the other hand, solutions and standards in the area of co-ordination of business processes are starting to appear (e.g., ebXML Business Collaboration Protocol, Web Services Flow Language [7]), but many issues are still unresolved.
- Finally, the top layer, called the cooperation layer, which deals with searching and finding new partners, negotiating and closing contracts and working together to set the boundaries of their co-operation. Infrastructural support at this level is still very much at the research stage. Research initiatives addressing directory services, such as UDDI and ebXML Registry, electronic contracting and virtual and networked organisations can be classified at this level.

Therefore, achieving full interoperability among two business partners means that they are able to collaborate at all levels of their enterprise architecture. In other words, interoperability does not only address the ability of software components to collaborate regardless of different languages, data formats, interfaces, execution platforms, communication protocols or message formats. A systematic approach to interoperability should also take into account interoperation issues at more abstract levels, such as business process interoperability. Business process interoperability is characterised as the ability of business activities of one party to interact with those of another party, whether or not these business activities belong to different units of the same business or to different businesses.

Some interesting research issues [8], [11], [17] in the area of interoperability among different business partners are presented below:

- Process Ownership: In many interorganizational settings (such as e-government, health care processes, educational programs, service industry) business processes are only sparsely structured and formalized, rather loosely coupled, and/or based on ad hoc cooperation and often there is no explicit or implicit agreement of process ownership. More research is needed to investigate in more detail the dilemmas of distributed versus centralized ownership and bring out different mod-

els of interorganizational process ownership to support handling the related issues in an integrated way.

- Reference Model: One of the basic obstacles in interoperability is the lack of a comprehensive model of interorganizational business processes as a basis for contracting and standardization.
- Autonomy and Privacy: an important issue for the enterprises that operate in collaborative environments is the assurance of their local processing privacy and autonomy.
- Heterogeneity-Dynamicity: There is low interoperability among companies due to their heterogeneity in hardware, software, and modelling. Besides, most research in this area assumes that the enterprises that are going to join in a network are homogeneous which is not the case especially when someone refers to Virtual enterprises that have a dynamic character.
- Dynamic processes: Process orchestration is starting to catch the attention of the industry, and as a consequence many competing proposals for process specification languages have been introduced, e.g., ebXML BPSS [18], WSCL [19], WSFL [23], XLANG [24], BPEL4WS [19], BPML [25]. However, neither of the current proposals provides a complete solution, nor do they address the future demand for dynamic processes. Thus, there is a great need for architectures readjusted to dynamic process enactment and execution infrastructures.
- Trust: this issue is vital in dynamic environments where a company needs to continuously establish collaboration with different enterprises and expose its processes and know-how.
- Process Modeling: during collaboration among companies business processes have a distributed nature. Therefore there is a challenge in enforcing transaction semantics over the entire process. In general, extending transaction models to support business processes has attracted considerable amount of research attention [11].
- Exception Handling: it is very important within an inter-enterprise collaboration framework to find ways in order to express and support exceptions that may occur (exception handling) during the execution of a collaborative business process.
- Methods and Tools: these are needed for building a library of reusable and composable common business documents and processes.
- Process Monitoring: a mechanism is needed that will aid not only at the process monitoring procedure in the distributed environment of the collaboration networks but also for the analysing the results.
- Searching/matching mechanisms: efficient registration and searching/matching mechanisms are needed in order for the enterprises to form effectively a collaboration network.
- Human Interaction in Business Processes: It is important to examine the requirements of many inter-enterprise business processes that contain a significant amount of human interactions and examine how traditional collaboration tools that are built around intra-enterprise collaborations (i.e., within a firewall) can be extended to an inter-enterprise environment, and how they can interoperate with inter-enterprise collaborative process management.

During the proposed Ph.D. research, investigation will be focussed on a subset of the issues which are more closely related to the Ph.D. topic as it will formed and specified in the near future.

## 4 Workflow Management Systems

Business processes can be thought of as a combination of real world models (usually called process models) and technology models (e.g. workflow models) [13]:

- The Process Model describes the steps that occur in the real world (e.g., the travel agent that fulfils a reservation, the ticket availability and payment of the ticket).
- The Workflow Model is the most popular technology for realizing process models. More specifically, a workflow model describes the technology interactions that support, interact with, or implement a real-world Process Model (e.g., reservation system X sends a request to system Y that checks the ticket availability).

Workflow models need Workflow Management Systems for their implementation, i.e. for the implementation of the business processes that have been enacted by business people.

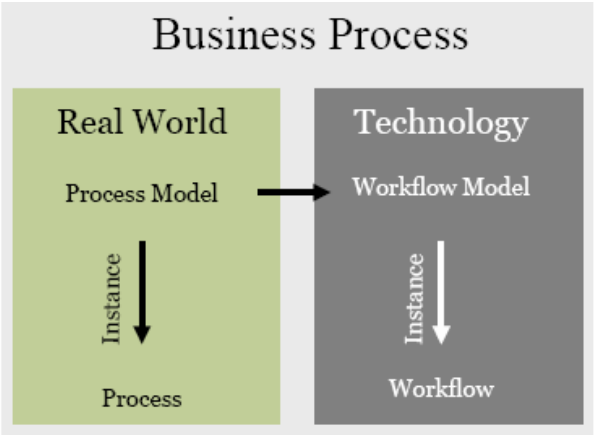


**Fig. 2.** Business Process = Process Model + Workflow Model [13]

In order to satisfy the needs that exist in a collaborative network, for a number of years the research on workflow management has focused also on interorganizational issues such as [8], [16]:

- Coupling of workflows.
- Contracting of workflows.
- Expanding Petri net application to workflow technology.

- Support through XML based schema definition.
- Web services for workflow.
- Business Process Execution Language for Web Services.
- Use of other standards (as sought by the Workflow Management Coalition).
- Autonomy of local workflow processing.
- Difference in levels of local workflow automation (e.g. degree of implementation and IT support).
- Variation in workflow control policy.
- Confidentiality, which actually prevents complete view of workflow.
- Low interoperability due to heterogeneity in hardware, software, and modelling in multiple organizations.
- Lack of cross-company access to workflow resources.
- Overload of WF servers.

Some of the above issues will be investigated in depth during the proposed Ph.D. research.

## 5 Virtual Enterprises

Nowadays, enterprises are adapting their traditional business models in favour of collaborative ones that allow them to enter into and exit from markets much faster and at much lower cost. These collaborative business practices, facilitated by technology, are giving rise to new organisational forms that are called Virtual Enterprises (VE). The interoperability of enterprise applications is a central issue in VEs. Although willing to co-operate and inter-operate with others to fulfil the common goals of the VE, every enterprise has its own conditions and requirements. For instance, it may wish to maintain its rights to local choices and solutions (e.g. proprietary enterprise applications), or it may wish to protect or restrict access to its proprietary information.

There are different Virtual enterprises categories [14]:

- Static Virtual Enterprises where partners form a static network with pre-defined process interfaces which are tightly coupled and well integrated. This category may be organized either by a centralized way, where one member of the network coordinates the relationship among the partners, or a decentralized way where business processes are deployed in a jointly, coordinated way.
- Dynamic Virtual Enterprises are also organized either in a centralized or decentralized way and characterized by inconstant business relationships which are mediated by a virtual market place and are evolving and dissolving based on specific criteria.

Dynamic Virtual Enterprises are created by following the steps below [14]:

- A company that desires to join a collaborative network declares its requirements to a marketplace.
- The marketplace provides matchmaking service in order to find candidate companies that are able to offer the services required.

- Last but not least a negotiation process takes place between enterprises which may have a contract as an outcome.

Some of the factors that lead individual companies to form virtual enterprises are: transaction costs, specificity of the product, flexibility, timeliness and costs [14]. Although research communities are focused in forming virtual enterprises many issues are still have not been answered especially when someone refers to dynamic virtual enterprises:

- Finding of required resources in the open market. This relates to issues: trust integration (cultures and systems).
- A framework where the timeframe of the collaboration is only for one project.
- Approaches where the collaboration rely on a leader or dominating broker which caters for resource selection.
- Forms of Virtual Enterprises where all partners are equal also attract the attention.
- The way that contracts are established among the companies that form a Virtual Enterprise.
- Data security.
- A common business process description language is required that should virtually be able to describe any task or process regardless of the industry.
- Mechanisms of change that are necessary within any partner network to allow for rapid configuration are also not yet researched [15].

All the above issues are very important for the effective function of virtual enterprises. During my research, I will focus on the research issues which are closely related to my Ph.D. topic, as it will be specified in more detail in the upcoming months.

## 6 Proposed Research Plan

During my research I am planning to work on inter-organizational collaboration. In general I am interested in dynamic environments which have specific requirements in terms of interoperability when it comes to forming collaboration networks. More precisely my main focus will be on two of the layers that appear in Fig. 1:

- On the business process layer (co-ordination of business processes) which is concerned with the joint business process among an enterprise network. This means that before the enterprises engage in a transaction they need to agree on the procedures of their joint business process. I am going to do research on the ways that the joint business process can be modelled while preserving the autonomy of the enterprises' private processes. Furthermore I will try to express and support exceptions that may occur (exception handling) during the execution of the joint business process.
- On the upper level of the infrastructure (co-operation between enterprises). Under this framework I will concentrate on how the interactions among the enterprises can be clearly defined, so there is no ambiguity as to what a message may mean, what actions are allowed and what responses are expected using semantics. Interoperability at this higher level is a challenging issue because it requires

an understanding of the semantics of partner business processes [6]. Moreover I will investigate the way contracts can be realised among enterprises in order to enable real-time transactions.

Last but not least, I am planning to investigate the use of web services as the underline technology for implementing my proposed framework.

In the immediate future I am planning to focus on the state-of-the-art of Virtual Enterprises, Workflow Systems and Semantics in order to have an overview of all the research issues in these areas, while I will continue looking for standards that enable the interoperability on the architectural layers of my interest.

## Acknowledgement

The author would like to thank her Ph.D. supervisor, Prof. Aphrodite Tsalgatidou, for her support in the development of this research plan.

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