Abstract—A key to maintain competitiveness is the ability of an enterprise to describe, standardize, and adapt the way it interacts with suppliers, partners, competitors, and customers. In the context of process orientation, enterprises today describe these procedures and interactions in terms of business processes, and invest huge efforts to describe and standardize these processes. The near future will bring an extension of these efforts towards interorganizational business processes. Modeling and managing business processes that span multiple organizations involves new challenges, mainly the ability to cope with change, decentralization, and the support for interoperability. In this paper, we propose a conceptual framework for interorganizational business processes modeling which highlights the interactions and exchanges between business partners.

Keywords—interorganizational business process, business process modeling, BPMN, UML profile, public business process.

I. OVERVIEW AND MOTIVATION

The fast and increasing development of networked business environments brings new ways of interaction among the enterprises, which eliminated the time and space gap between business partners. Interorganizational systems are a new organizational structure that accomplishes the requirements of dynamism and agility that electronic commerce entails. In order to overcome the shortcomings of the traditional document-centric focus, a lot of research has been undertaken to move towards process-centric Interorganizational Information Systems (IOS) approaches. Business process models capture the business information that is required in each step of an IOBP. A business process is defined as an organized group of related activities that together create customer value [7]. IOBP is a special type of a business process that involves two or more partners. IOBP is about aligning the information systems of the business partners, i.e. keeping all relevant business objects (e.g. purchase orders, line items, etc.) in an aligned state.

IOS covers a wide spectrum of interactions among business partners. The types of interactions depend on the usage scenarios, parties involved, and business requirements. Each framework makes specific tradeoffs with regard to the requirements of IOS interactions. It is therefore important to determine the relevant requirements and understand the related tradeoffs when evaluating models of interactions. Medjahed et al. [9] identify a set of dimensions to study interaction issues in IOS. They consider the following dimensions: coupling among partners, heterogeneity, autonomy, external manageability, adaptability, security, and scalability.

Our aim in this paper is to provide a broad overview of the challenges related to interorganizational (B2B or collaborative) business processes modeling. To this end, we suggest some guidelines and put forward some solutions to face these challenges. First, we examine the concept of IOBP. Then, we analyzed the particularities of and the requirements for IOBP modeling. We focused on recent studies with more intensive forms of IOBP modeling. It is therefore important to consider the relevant requirements of IOS and understand the related influences when we model their business processes. The remainder of the paper is structured as follows. In section 2, we present a development method for designing an IOS. Section 3 investigates the field of IOBP modeling approaches and techniques. Finally, section 4 summarized the main ideas of this work and gives an overview of future work.

II. THE INTERORGANIZATIONAL SYSTEM DEVELOPMENT METHOD

Automating the exchange of business information between business partners exists for a while. The business processes between two different organizations participating in an IOS must be defined. For this purpose a commonly accepted methodology is needed based on the refined Open-EDI reference model [13]. Business-to-business (B2B) electronic commerce builds upon interorganizational business processes that cross the borders of enterprises. Their design and implementation presupposes a different approach than intra-organizational processes do. Experience shows that bottom-up approaches starting from the IT layer of a single enterprise - expecting that all other business partners adjust to it – do not work out. Instead, what is needed are end-to-end and strategy-to-code methods for designing and deploying IOS initiatives as illustrated in Fig.1.

The business strategy phase of IOS development identifies “what” to do. It specifies the critical success factors for an IOS project, its requirements, constraints risks, costs and benefits.
The business process engineering phase addresses the “how.” The task at hand is the mapping and engineering of the IOBP. IOBP may be loosely coupled as in the case of open markets, or they may be tightly coupled as in the case of a supply chain management (e-procurement) where process handoffs are made electronically. The output artifacts in this layer are the specification of IOBP in a formal language, in such a way that they can be verified. In this case, according to the results of the verification, it is possible to go back to the modeling phase in order to correct the IOBP. Several cycles of modeling and verification can occur.

![Diagram of Interorganizational Business Processes Model](image)

Fig. 1: Interorganizational systems: A three layer framework

Finally, once the IOBP were agreed, the technical layer (implementation and technology standards) corresponds to the Functional Service View (FSV) of the Open-EDI model which separates the “what” in the Business operational View (BOV) from the “how” in the FSV [13]. It consists of selecting the technology of implementation [12, 19, 20] and generating the interorganizational specification that fulfil the IOBP defined in the previous layer. Deployment artifacts comprise business process specifications, workflow descriptions or document schemes in a machine-processable language. It includes also the software environments which correspond to concrete implementations of information systems.

### III. The Interorganizational Business Processes Modeling

Traditionally, business process modeling focused on intraorganizational business processes in order to capture workflows that are internal to an enterprise. Internal processes are always modeled from the perspective of the respective company. In a collaborative context, however, a partnerspecific view on a process is not sufficient. If each participant in a collaborative process describes its own perspective on the same process in isolation, the resulting process descriptions will most likely not match. Thus, modeling interorganizational processes requires a global perspective.

Resulting models usually hide implementation complexity and are on a rather abstract level. Other approaches are more implementation oriented and rather provide a graphical interface for workflow languages or Web Service orchestrations/choreographies.

#### A. Requirements for Interorganizational Business Processes

Important contributions to handling the particularities of interorganizational business processes come from research on workflow management, e.g. Collaborative Process Management, the Public-To-Private Approach and the Process-View Model [8]. The defining characteristic of an IOBP is that two or more autonomous organizations jointly execute a process with the purpose of creating a certain output. Usually, organizational boundaries are associated with a lack of transparency, redundancies (e.g. the manual re-entry of data) and time lags, thereby delaying the process flow. Although most of these inefficiencies are also present in the case of cross-functional coordination, some specific challenges exist at the boundaries of organizations which necessitate deduction of requirements for their representation in future process architectures (see Table I).

<table>
<thead>
<tr>
<th>Challenges &amp; requirements</th>
<th>Contributions from BPM, Workflow Management and B2B integration</th>
</tr>
</thead>
<tbody>
<tr>
<td>External processes as “black box” [8]</td>
<td>• Graphical representation of inter-organizational business process</td>
</tr>
<tr>
<td>Representation of inter organizational business process</td>
<td>• Introduction of artefacts related to organization / roles, messages /business documents</td>
</tr>
<tr>
<td>Lacking clarification of responsibilities at company boundaries ([11, 8])</td>
<td>• Graphical representation using swimlanes, pools or domains</td>
</tr>
<tr>
<td>Allocation of tasks to actors</td>
<td>• Organizational / role model to include external parties</td>
</tr>
<tr>
<td>Different process logic and terminology ([6], [8])</td>
<td>• Data dictionary, glossary</td>
</tr>
<tr>
<td>Alignment of semantics underlying the business process</td>
<td>• Information modeling</td>
</tr>
<tr>
<td>Process autonomy ([2], [8], [11], [18])</td>
<td>• View concepts</td>
</tr>
<tr>
<td>Differentiation between public</td>
<td>• Independence between public and private business processes</td>
</tr>
</tbody>
</table>

#### TABLE I: Challenges and requirements of IOBP Modeling
A key issue discussed in the literature with respect to IOBP is the required balance between trust and control, visibility and privacy. Addressing this delicate balance, solutions vary from complete central control to pure distribution. In general, a high degree of central control and required visibility imposes constraints on the internal operations of an organization, thus reduces its flexibility.

From the point of view of information systems, these IOBP models impose several challenges to support the management of public business processes in interorganizational relationships:

- Autonomy, which implies that enterprises should be able to behave as autonomous entities, hiding their internal decisions, activities and processes. Information systems that manage interorganizational relationships in each enterprise have to be independent.
- Decentralized management of the business processes jointly managed by the enterprises.
- Peer-to-Peer interactions among the enterprise systems that manage interorganizational relationships. This means that systems have to interact in a direct way without mediation of an independent third party system.
- Negotiation has to be included in the public process management.

Moreover, Business Process models are developed for the purpose of documentation, optimization and automation of business processes. Though models developed for establishing IOBP share these objectives, they differ in various aspects from the business processes used only inside one organization, e.g.:

- Need for Information Hiding. Though the information describing interactions between organizations should be visible, other parts of process model should remain inside one organization. Therefore, few enterprises like to expose their internal processes to the outside world. This means that the properties of the overall business-to-business collaboration cannot be based on the actual detailed local processes run by the enterprises, but rather on the externally visible behaviour and the associated models to represent it.
- Need for exact description. If elements are described ambiguously, this will lead to misinterpretations. Though this criterion is also relevant for corporate internal use, technical and cultural differences are usually bigger between organizations, increasing the probability for misunderstanding. Additionally, the distance between stakeholders is bigger, thus misunderstandings are harder to resolve.

B. Interorganizational Business Processes Modeling Architecture

Business processes are market-centred descriptions of an organisation’s activities. To achieve seamless business processes across enterprise borders the heterogeneity of different terminologies and modelling notations used within the organizations have to be overcome. However, autonomy of the different business partners has to be taken into account meaning that an organization should be able to flexibly participate in business relations. In order to make IOBP work, each involved enterprise has to implement not only its internal processes (private processes), but also its external behavior (public processes). A private process describes internal executable activities that support the activities of public processes. A public process defines an external message exchange of an organization with its partners according to a message exchange protocol such as EDI and RosettaNet [19]. The public processes of two companies have to match in order to allow IOBP to work. For example, if one company sends a purchase order (PO) then the other company must be able to receive the PO in the format sent over the same network. Moreover, Public processes can be seen as interfaces of private processes and should contain all information necessary to enable the interaction of different private processes. Therefore, beside the sequence of functions contained in an interaction, public processes also have to display information regarding the exchanged data (e.g. which structure an exchanged message has), the goods and services exchanged as well as the organizational departments and roles involved in the interaction.

As depicted in Fig. 2, these approaches distinguish between the internal process (private process) and the interorganizational process (collaborative or B2B). On private process level, organizations model their internal business processes according to a modelling approach or notation that is most suitable for internal demands independently of the modelling methodologies used by the business partners [18].

Furthermore, whereas public processes appear to provide stable interfaces with external partners, private business processes might be subject to change more frequently. So far, selective visibility of internal processes has been mainly addressed by extensions to workflow concepts, but is also
gaining attention from the business process modeling community. Appropriate means for selective visibility include abstracting those parts of the business process considered internal as well as the creation of (partner-specific) views on internal business processes.

![Interorganizational business process](image)

**Fig. 2. Inter-Organizational Business Process architecture**

By hiding the internal process implementation like the specific modeling language and protecting also critical internal information public processes provided by an organization connect private processes to a collaborative business process, the third modeling layer. This level defines the interactions of two or more business entities taking place between the defined public processes.

One possible language for modelling IOBP could be the Business Process Modeling Notation (BPMN) which consolidates ideas from divergent notations into a single standard notation. Examples of notations or methodologies are: UML Activity Diagram ([16],[17]), UMM [21], ebXML Business Process Specification Scheme (BPSS) [12], RosettaNet PIPs [19], and EPC [15].

**C. Interorganizational Business Processes Modeling Languages**

The origins of process modeling languages are quite diverse, although two dominant approaches can be observed; one based on graphical models, and the other based on rule specifications. The main standards addressing business process modeling considered in this work are outlined below.

- **EPC** – Event-Driven Process Chains (EPCs) are a process-oriented modeling technique proposed by Keller et al. [15]. EPC is a business process modeling language, focusing on control flow dependencies of activities in a business process. It is utilized in the ARchitecture of Integrated Information Systems (ARIS) by Scheer [15] as the central method for the conceptual integration of the functional, organizational, data, and output perspective in information systems design. ARIS is a tool set that supports besides other modeling approaches the EPC approach and is continuously extended to support recent developments in the IT-world. The modeling approach is based on a sequence of events and functions (activities) that constitute a business process. Logical connectors (logical AND, OR and XOR) enable the description of branching actions and conditions for the execution of parallel activities. Extended event-driven process chains support the modeling of resources, data objects, organizational units and services. Further, the linkage between processes is supported.

- **UML** – The Unified Modeling Language is an object-oriented modeling language from the OMG. It specifies and visualizes models of software systems. It has become the generic modelling standard applicable to any software development project, and knowledge of UML is widespread. Its extensive use has raised numerous application and implementation issues by modelers and vendors. UML 2 was produced to address many of these issues — including business process modeling [17]. In order to describe the behavior of a business process, UML activity diagrams might be used. For specifying interactions between participants on a lower level, one might also utilize sequence diagrams. Many UML approaches studied ([5], [8]) offer means to model collaborations between entities and to derive deployment artifacts thereof.

- **BPMN** – The Business Process Modelling Notation is an open graphical notation standard for business process modelling that was developed by BPMI, now merged with OMG [3]. It is based on well-known flowcharting notations and thus intuitive for business analysts. The objective is to support process management by both technical users and business users by providing a notation that is intuitive to business users yet able to represent complex process semantics. BPMN defines Business Process Diagrams (BPD) [3] to capture a business process. A BPD describes the flow of a process using flowchart techniques. The modeled process might be either internal to a company (private process) or collaborative if executed between two or more participants (public process). Furthermore, BPMN allows modeling the interface that a private process exposes to its outside world. The interface of such a process defines what message exchanges are required in order to interact with it. Process interfaces are called abstract processes.

- **UMM** – UMM has been developed by UN/CEFACT to analyze and design B2B business processes and to concentrate on business semantics [21]. UMM is a UML based methodology for capturing the requirements in an IOBP. It is independent of the underlying transfer syntax. The overall goal of the UMM methodology is to create a global choreography of the business process. If two business partners interacting with each other each defined their own choreography for the business process the resulting choreographies are unlikely to match. UMM pursues a top down approach by first defining the global choreography from which the local choreographies are derived. Hence it is ensured, that both choreographies are
complementary. UMM is built upon the UML meta model and defined as a UML profile [21] e.g. a set of stereotypes, tagged values and OCL constraints.

### D. Comparative study of IOBP Modeling languages

The increasing interest in business process modeling has resulted in the appearance of various business process modeling languages. Today, there are several notations that can be used for business process modeling: UML 2.0 Activity Diagram [17], Business Process Modeling Notation [3], Event Driven Process Chain (EPC) [15], Integrated DEFINition Method 3 (IDEF3), and others. These languages express certain aspects of processes, for example, activities and roles, and address different application areas. However, no one of these languages is predominant in the business process modeling area [10]. One major reason is the wide disparity in the needs and viewpoints of various modelers and designers.

<table>
<thead>
<tr>
<th>Edition</th>
<th>Source domain</th>
<th>Specifi cation</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Keller, Nüttgens &amp; Scheer</td>
<td>Process Engineering</td>
<td>Proprietary</td>
<td>Description, Analysis</td>
</tr>
<tr>
<td>OMG</td>
<td>Software Engineering</td>
<td>Open</td>
<td>Description, Enactment</td>
</tr>
<tr>
<td>1992</td>
<td>BPEL</td>
<td>Open</td>
<td>Description, Enactment</td>
</tr>
<tr>
<td>BPMI, OMG</td>
<td>Process Engineering</td>
<td>Open</td>
<td>Description, Enactment</td>
</tr>
<tr>
<td>UN/CEFA CT</td>
<td>Process Engineering</td>
<td>Open</td>
<td>Description, Enactment</td>
</tr>
<tr>
<td>2006</td>
<td>Process Engineering</td>
<td>Open</td>
<td>Description, Enactment</td>
</tr>
<tr>
<td>2006</td>
<td>Process Engineering</td>
<td>Open</td>
<td>Description, Enactment</td>
</tr>
<tr>
<td>2006</td>
<td>Process Engineering</td>
<td>Open</td>
<td>Description, Enactment</td>
</tr>
<tr>
<td>2006</td>
<td>Process Engineering</td>
<td>Open</td>
<td>Description, Enactment</td>
</tr>
<tr>
<td>2006</td>
<td>Process Engineering</td>
<td>Open</td>
<td>Description, Enactment</td>
</tr>
</tbody>
</table>

BPMN is able to present private processes, public processes and collaboration processes. Most BPMN elements can be mapped to execution but some are used purely for informative purposes. BPMN specifies mappings to BPEL only for internal processes, but defines no complementary generation of BPEL artifacts for collaborative processes. According to the BPMN specification, BPSS is considered as a target language for collaborative BPD’s. One of the shortcomings of BPMN is that it lacks formal semantics, and the specifications for certain elements can also be considered inadequate for execution purposes. Additionally, the specification does not include an XML interchange format for BPMN diagrams. For this purpose, OMG has subsequently introduced the Business Process Definition Meta-model (BPDM) specification.

Since UMM is defined as a UML profile, a business analyst may use any UML tool to model UMM business collaboration models. As we outlined before, UMM artifacts are based on a specific subset of UML to capture complex business collaborations. Between these artifacts, a number of
dependencies and constraints exist. If a regular UML tool is used for UMM, these rules are not enforced.

From table III we observe that none of the investigated approaches supports all requirements that should be addressed by methodologies, languages, tools, and standards facilitating the modelling of CBPs.

IV. CONCLUSION AND FUTURE WORKS
The importance of interorganizational processes has been widely recognized, leading to a variety of approaches and proposed solutions to their design and implementation. In this paper, we discussed the important and still unresolved research issue of applications for modeling B2B scenarios among diverse businesses. Modelling IOBP requires specific constructs and methodologies, and requires a high-level model and the corresponding executable one for exchanging and merging behaviours, resources and activities.

This paper constitutes a research plan aiming at a PhD degree which concentrates on IOBP modeling. We aim at proposing a conceptual framework for designing and implementing an IOS. Over the last years, a lot of methodologies for modeling business processes have been developed. Some of them are based on special notations often defined by standardization bodies. Others customize the UML for business process modeling needs. The IOBP modeling approaches investigated introduce a representation of the IOBP, which uses either an existing modeling notation or its extensions. Specific artifacts are necessary for describing IOBP, among them external organizations, roles or partner types as well as messages, business documents and channels. Our research goals are based on the intention not to contrive yet another modeling approach, but to combine existing ones to an integrated top-down methodology.

Research on specifying, modeling, testing and validating, framework for IOBP is under current intensive work as follows:

1. Extending an existing BPML according to the metamodel with missing concepts and notations
2. Common Meta-model for EPC/ UML AD/ BPMN; Automatic transformation/switch between EPC/ UML AD and BPMN model
3. Transformation of an adopted Business Process Model to an Execution Language (BPEL); case of an e-procurement system

We will highlight this framework by simulation work based on a case study in the e-procurement domain.

REFERENCES