

# A Categorization of Collaborative Business Process Modeling Techniques

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## Abstract

*Business Process Modeling (BPM) is one of the key factors in defining service-oriented solutions for business collaborations. Like in traditional software engineering there is a need for adaptable methodologies to develop information and communication technology (ICT) systems supporting collaborative business processes. In this work we introduce a categorization for the classification of modeling languages and approaches used to model collaborative business processes. Considering an example, we will show how the classification of modeling languages and approaches facilitates the development of methodologies for collaborative business processes.*

## 1. Introduction

Over the past few years, enterprises have been undergoing a thorough transformation in reaction to challenges such as globalization, unstable demand, and mass customization. A key to maintain competitiveness is the ability of an enterprise to describe, standardize, and adapt the way it reacts to certain types of business events, and how it interacts with suppliers, partners, competitors, and customers. In order to enable business processes to collaborate with partners and to facilitate the composition of business processes, the paradigm of service-orientation is applied to business process modeling [11]. Business processes and activities are treated as components providing services to and consuming services from other business process components. Interacting business processes form a network of interconnected processes where conversations are conducted.

For building up collaborations between enterprises, supported by ICT systems, it is often not sufficient to migrate only to a service-oriented architecture (SOA) by realizing processes and ICT systems functionality in service components. Like for enterprise internal ICT systems there is a need for methodologies supporting

the composition, design and implementation of cross-organizational business process collaborations in ICT systems. Such methodologies consist of a process for the development of the ICT systems and of a set of modeling languages inclusive modeling conventions to be used for modeling the artifacts in the software development. Unfortunately one methodology can often not be applied to any development project without modifications or adjustments. This may depend on the size and goal of the project, the involved parties (organizations), former development processes or methodologies, the complexity of (business) processes and applications, the sort of application and their need for integration, and other factors.

In this paper we introduce a categorization framework for the classification of modeling languages and approaches used to model collaborative business processes in a service-oriented environment. The framework will facilitate and improve the development and adjustment of methodologies for collaborative business processes. Considering a methodology for collaborative business processes we will illustrate the use of the categorization. By classifying modeling languages and approaches, the resulting classification forms a perfect starting point for the choice of modeling languages and concepts for the models and artifacts of the methodology to be developed.

This paper is organized as follows: Chapter 2 introduces important standardization efforts and related technologies in the context of business process modeling. After the presentation of an example how modeling of collaborative business processes can be introduced into a software engineering process (chapter 3), we provide a detailed look at the categorization framework for modeling languages and approaches in chapter 4. After presenting the application of the categorization framework and how the classification result can be used for methodology development (chapter 5), chapter 6 closes with conclusions and outlook.

## 2. Background: Standardization Efforts and Related Technologies

In this chapter we will have a closer look at the standardization efforts and related technologies.

### 2.1. Standard Organizations

This section gives a short overview of the standardization organizations and efforts, being the most promising ones in the context of BPM.

**BPML.org:** The Business Process Management Initiative (BPML.org) is a non-profit organization that aims to empower companies to develop and operate business processes that span multiple applications and business partners. BPML embraces existing standards where appropriate, working with complementary standardization bodies such as the OMG, WfMC and OASIS. In areas where standards are lacking, BPML focuses on standard developments to support the entire life-cycle of business process management [4].

**OASIS:** The Organization for the Advancement of Structured Information Standards (OASIS) is a not-for-profit, international consortium that drives the development, convergence, and adoption of e-business standards. OASIS produces worldwide standards for security, Web services, conformance, business transactions, supply chain, public sector, and interoperability within and between marketplaces [19].

**OMG:** The Object Management Group (OMG) is an open membership, not-for-profit consortium that produces and maintains computer industry specifications for interoperable enterprise applications. With the Model Driven Architecture (MDA) the OMG provides an open, vendor-neutral approach to the challenge of business and technology change. Based upon established standards (like MOF, UML, OCL, etc.), MDA aims to separate business or application logic from underlying platform technology [22].

**UN/CEFACT:** The United Nations, through its Centre for Trade Facilitation and Electronic Business (UN/CEFACT), supports activities dedicated to improving the ability of business, trade and administrative organizations to exchange products and services effectively. It develops and promotes methods to facilitate processes, procedures and transactions, including the relevant use of information technologies [26].

**W3C:** The World Wide Web Consortium (W3C) develops interoperable technologies to make the Web a robust, scalable, and adaptive infrastructure for a world of information. W3C's long term goals for the Web are: *Universal Access* to the Web all people of culture, education, material resources, etc.; *A Semantic Web* that permits each user to make the best use of the resources

available on the Web; *A Web of Trust* with careful consideration for the novel legal, commercial, and social issues raised by this technology [31].

**WfMC:** The Workflow Management Coalition is a non-profit, international organization of workflow vendors, users, analysts and university and research groups. The Coalition's mission is to promote and develop the use of workflow through the establishment of standards for software terminology, interoperability and connectivity between workflow products. The Coalition aims to increase the value of customers' investment with workflow technology and decrease the risk of using workflow products [30].

### 2.2. Business Process Modeling

The following important business process modeling approaches are discussed in more detail in this paper. Therefore we provide a short introduction to them.

**ARIS:** The Architecture of Integrated Information Systems (ARIS) (see [25]) forms a framework for developing and optimizing integrated information systems. The ARIS concept serves as model for creating, analyzing, and evaluating business management process chains. Thus ARIS allows the description of business processes and the decomposition of processes into different views to reduce complexity.

**BPML:** The Business Process Modeling Language (BPML) specification provides an abstract model for expressing business processes. BPML defines a formal model for expressing abstract and executable processes that address all aspects of enterprise business processes. [6]

**BPMN:** The Business Process Modeling Notation (BPMN) specification, produced by BPML.org [4][5] provides a graphical notation for expressing business processes in a Business Process Diagram. 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.

**BPDM:** The Business Process Definition Meta-model (BPDM) provides an abstract model for defining business processes (see [16]). As BPDM provides basic concepts from business process modeling as well as support for modeling of collaborations, it appears a promising approach to combine the openness and generality of UML with the expressiveness and vocabulary required for business process modeling. BPDM is specified as a UML 2.0 profile enabling generic UML tools to both author or consume business models.

**ebXML BPSS:** The ebXML Specification Schema, sponsored by UN/CEFACT and OASIS, provides a standard framework by which business systems may be

configured to support execution of business collaborations consisting of business transactions. ebXML relies on services offering data centric 'Business Service Interfaces' on the basis of which business transactions are specified. [28]

**WSBPEL:** WSBPEL has its origins in the join of IBM's Web Service Flow Language (WSFL) and Microsoft's XLANG to one web service centered process execution language. Defining a notation to specify business process behavior based on Web Services, executable business processes model actual behavior of a participant in a business interaction, while abstract processes specify the visible message exchange of each of the parties involved in a business protocol. [21]

**WS-CDL:** The Web Service Choreography Description Language (WS-CDL) is a specification produced by the Web Service Choreography Working Group of the W3C. WS-CDL, as an XML-based language, describes peer-to-peer collaborations of parties from a global viewpoint by defining their common and complementary observable behavior. [32]

### 3. Integration of BPM into Software Engineering Process

In the context of process orientation, today enterprises describe their 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 collaborative business processes. Modeling and managing collaborative business processes that span multiple organizations involves new challenges, mainly regarding the ability to cope with change, decentralization, and the required support for interoperability. We will have to deal with a raising complexity of collaborative business processes and a demand to configure those processes to changing environments and requirements. Like in traditional software development one possibility is to meet these challenges by applying sound and adaptable methodologies to the development of ICT systems supporting and implementing collaborative business processes.

#### 3.1. Challenges of BPM in a Software Engineering Process

Models describing for example enterprises' structures or process flows are applied for the analysis, design and implementation of ICT systems. Since it is rarely sufficient to use only one type of model for developing ICT systems, several models describing one ICT system are used. Those models can differ in the point of view from which they are described, the phase

of modeling in which they are used, the target group of persons dealing with the model or merely the level of abstraction and the granularity of the model. Facing these different purposes of application and variety of objectives models are used for, it is consequential that a huge number of modeling languages and approaches has been developed. In many cases several modeling languages are available for modeling one specific model only varying in their syntax or in the semantics of some model elements.

In addition to the different model types various development processes comprising tasks like requirements engineering, analysis, design, implementation and deployment exist. In this context the Model-driven Architecture<sup>1</sup> (MDA) of the OMG lends itself as a framework for such development processes. Even when the internal development processes of the organizations, aiming to set up their internal business processes, differ, by applying the MDA as framework for software development it is ensured that modeling and development artifacts of the various organizations can be categorized to similar level of abstraction.

#### 3.2. Developing Methodologies for Collaborative BPM

Providing methodologies for software development comprises the specification of two main parts: a process for the development of the software on the one side and modeling languages and concepts for the various models and artifacts on the other side ([2]). Methodologies for the development of collaborative business processes (CBP methodologies) also have to take into account the methodologies used by the organizations participating at the collaborative business process (CBP). This comprises the process of developing business processes as well as modeling concepts used for representing business processes. Challenges arising for the development of collaborative business processes will be show by a simplified example (figure 1).

The example in figure 1 shows two enterprises A and B, planning to set up CBPs. Therefore they plan to develop a methodology or adjust an existing methodology. Both enterprises, already having their own methodology for developing business processes, have set up their (internal) business processes supported by ICT systems. Since their development processes are based on the MDA as a framework for software development both enterprises have modeled computational independent, platform independent and platform specific models (CIMs, PIMs and PSMs) for their business processes. Model transformations will be speci-

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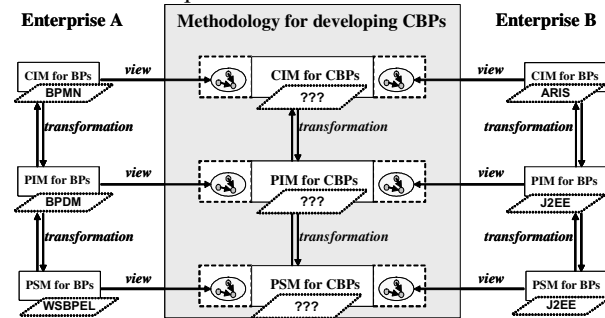
<sup>1</sup> The Model Driven Architecture (MDA) is a framework for software development driven by the Object Management Group. [23]

fied by the OMG's emerging Query/View/Transformations standard (QVT)<sup>2</sup>.

The CBP methodology will naturally also adhere to the MDA framework and define CIMs, PIMs and PSMs. In order to develop a collaborative business process it is necessary that information about the public or external process interfaces of the participating enterprises is made available to the collaborative business process models. This information will be provided by QVT views.

After determining the development process for CBPs, appropriate modeling languages and concepts have to be chosen for the models of the CBP methodology. Since this task is similar for all of the three main model types we will only consider CIMs in more detail: For modeling at computation independent level enterprise A uses the modeling language BPMN while enterprises B uses ARIS. Two significant questions arise:

- Which modeling language or modeling approach shall be chosen for modeling the collaborative business processes at computation independent level?
- Which concepts of the BPMN model (enterprise A) and the ARIS model (enterprise B) have to be provided by the participants to the CIM for collaborative business processes in the form of views?



**Figure 1: Methodology for developing CBPs**

Such information first has to be determined before appropriate modeling languages, approaches and concepts can be chosen for a CBP methodology. As at platform independent level (enterprise A uses BPDM and enterprise B uses J2EE) as well as at platform specific level (enterprise A uses WSBPEL and enterprise B uses J2EE) similar information has to be gathered, a categorization framework for classifying business process modeling languages and approaches would be an important support for the development and adjustment of CBP methodologies. The next chapter intro-

duces a categorization framework classifying business process modeling languages and approaches by criteria important for CBP methodologies.

## 4. Categorization Framework

Models of ICT systems and business processes of different organizations do often not differ vast in what is modeled (the application of the MDA and a service-oriented architecture assumed) they more differ in how concepts are modeled. When developing or providing a methodology, one main challenge is to identify the appropriate modeling languages and approaches, which can be used for the description of the different models and artifacts to develop. The 'how' something is modeled and which modeling concepts are used is determined to a huge extend by modeling languages and modeling approaches. This chapter therefore provides a categorization framework for modeling languages and modeling approaches in the context of business process modeling, facilitating the comparison and the development of methodologies.

### 4.1. Design of the Categorization Framework

Basis of the classification framework is the assumption that service-orientation is applied to business process modeling. There business processes and activities are treated as components which providing and consuming services to and from other business process components. Collaborating business processes form networks of interconnected processes where conversations are conducted.

The classification framework consists of five criteria by which modeling languages and modeling approaches are categorized. These criteria are (1) Level of Abstraction, (2) Modeling of Business Processes, (3) Notation, (4) Standardization and (5) Tool-Support. The first two criteria are the core criteria of the classification framework, since they are most important for developing integrated and adaptable methodologies. Modeling languages and modeling approaches are first classified for which level of abstraction they can be used and which concepts for modeling business processes they support, while the other criteria can be used to evaluate the applicability (provided notation and tool-support) or relevance (standardization).

This chapter's following sections provide a more detailed look at the differentiation criteria of the classification framework.

<sup>2</sup> Query/View/Transformations (QVT) is Request for Proposal of the OMG for the standardization of model-to-model transformation as a key technology for OMG's MDA. A *transformation* generates a target model, which may be independent, from a source model. A *view* is a model that is completely derived from another model and cannot be modified separately from this model. (see [12])

## 4.2. Framework Criteria – Level of Abstraction

The first criteria of the classification framework aims for methodologies' process component, describing the process of developing ICT systems. A software development process specifies different models to develop, target groups for specific models and tasks, and the granularity or the level of abstraction of models.

The MDA provides a framework for software development driven by the OMG. According to [23] it provides a means for using models to direct the course of understanding, design, construction, deployment, operation, maintenance and modification of software systems. Since MDA focuses on models in all phases of development, it also describes certain kinds of models to be used, how those models may be prepared and the relationships between different kinds of models. The MDA specifies three view points on a system, a computation independent viewpoint, a platform independent viewpoint and a platform specific viewpoint, in order to achieve portability, interoperability and reusability. Those viewpoints are used for abstraction, in order to focus on particular concerns within a system and suppressing selected detail to establish a simplified model. According to these viewpoints MDA specifies three models types differing in their level of abstraction: a computation independent model (CIM), a platform independent model (PIM) and a platform specific model (PSM). (The description of the models is based on [23])

- A **computation independent model (CIM)** is a view of a system from the computation independent viewpoint. It focuses on the environment and the requirements of a system while the details of the structure and processing of the system are hidden. Therefore a CIM has a low granularity. As a domain or business model a CIM describes the requirements of a system and the situation in which a system will be used. The CIM plays an important role in bridging the gap between those that are experts about the domain and its requirements on the one hand, and those that are experts of the design and construction of the artifacts that together satisfy the domain requirements, on the other. A CIM might consist of two UML models, from the ODP enterprise and information viewpoints.
- A **platform independent model (PIM)** is a view of a system from the platform independent viewpoint focusing on the operation of a system while hiding the details necessary for a particular platform. A PIM shows those parts of the complete specification that do not change from one platform to another. It has a medium granularity by describing how requirements are realized by system functionality but

not showing details of the use of specific platforms. A PIM will normally be suited for a particular architectural style and provides platform independent solutions to system requirements, which are often developed in the analysis but also in the design phase. A PIM might consist of enterprise, information and computational ODP viewpoint specifications.

- A **platform specific model (PSM)** is a view of a system from the platform specific viewpoint by combining the platform independent model with additional detail of the use of a specific platform by a system. Often, at present, this model is in the form of software and hardware manuals or is even in the architect's head. A PSM combines the specifications of the PIM with the details that specify how a system uses a particular type of platform. It has a high granularity since it can serve as an implementation by providing all the information needed to construct a system and to put it into operation. Beside architects, system designers and programmers have to read and use this model. Since PSMs are implemented we have them to be considered at least for the design and implementation of a system.

The Level of Abstraction will be the first differentiation criteria of the categorization framework, since other possible differentiation criteria like the granularity of ICT systems' models, the phase of the software development process in which the models are used, the target group for which a model is developed or the viewpoints of the ISO Reference Model of Open Distributed Processing<sup>3</sup> (RM-ODP) can be assigned to specific level of abstractions.

## 4.3. Framework Criteria – Modeling of Business Processes

The second criteria of the categorization framework takes into account the application domain 'business process modeling' of the modeling languages and approaches. This differentiation criteria distinguishes between **private processes**, **public processes** and **collaboration processes** for modeling business processes.

- **Private Process:** Private processes (PrPs) are internal to an organization or a service component. Describing the internal realization of a software component it can be executed (e.g. in workflows) and

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<sup>3</sup> The ISO Reference Model for Open Distributed Processing (RM-ODP) offers a conceptual framework and an architecture integrating aspects related to the distribution, interoperability and portability of software systems. It manages complexity through a 'separation of concerns', addressing problems from different points of view [29].

uses orchestration<sup>4</sup> for the description of the process control flow.

- **Public Process:** Organizations' or service components' public processes (PuPs) represent the interactions between the private process realization and other process components. Public processes can be used for modeling in choreographies<sup>5</sup>, describing the interactions of e.g. one participating party, as well as in orchestration, describing public behavior a sub-process offers to its super-process.
- **Collaboration Process:** Collaboration processes (CPs) are used to model choreography as interaction protocols of collaborations from the global viewpoint of an external observer. A collaboration process can be composed and shown by two or more public processes communicating with each other.

This classification of modeling business processes in a service-oriented environment into private, public and collaboration processes and the specification of these concepts are defined in basically the same way by a large number of standardization organizations like BPMI, OASIS, OMG, UN/CEFACT, W3C or WfMC. Though their approaches are not exclusively limited to the description of business processes in a service-oriented architecture the following gives an overview of the concepts specified by these organizations for modeling business process components:

- **BPMI.org:** BPMI.org considers an e-Business process conducted among two business partners as made of three parts: a public interface and two private implementations [5]. The public interface is considered as the 'touch-points' between the collaborations' participants and supported by the abstract processes (PuPs). Interaction protocols describing the message exchange patterns between the partners involved are modeled as collaborative processes (CPs). Finally private implementations, specific to every partner, are described in any executable language, called private business processes (PrPs) and normally realized by orchestration [7].
- **OASIS:** OASIS provides and supports several specifications addressing business processes modeling, like the Electronic Business Service Oriented Architecture (ebSOA) [20] or WSBPEL [21]. In ebSOA a collaboration is seen as a bilateral agreement, which can be fulfilled by one or more business processes. Business protocols, an analogous concept of WSBPEL, give a formal description of

business interactions by specifying the mutually visible message exchange behavior of each of the parties involved in the protocol (CPs). WSBPEL distinguishes between public and internal aspects of business processes like the categorization framework does between public and private processes.

- **OMG:** The OMG's main approach to address business process modeling is BPDM. BPDM as a meta-model describing logical relationships [14] focuses on two aspects of business processes modeling: the internal behavior realized by operational processes (PrPs), using a flow model for describing how a process is performed, and the external interactions, used to connect processes with other components in a service-oriented architecture. The external view specifies partner roles describing external process interactions called abstract processes (PuPs) as well as interaction protocols between those partner roles. Interaction protocols are modeled as collaborative processes (CPs) between partner roles implemented by operational processes. [11]
- **UN/CEFACT:** UN/CEFACT supports two main specification documents for business process modeling: the Unified Modeling Methodology (UMM) [27] and the ebXML Business Process Specification Schema (ebXML BPSS) [28]. Both, UMM and ebXML BPSS, focus on collaboration between business partners. UMM provides a procedure for specifying collaborative business processes (called business collaborations) involving information exchange in a technology-neutral, implementation independent manner. ebXML BPSS, based on UMM, defines a standard language supporting the specification and choreography of Business Transactions into Business collaborations. [28]
- **W3C:** Within the W3C the Web Service Choreography Working Group deals with modeling collaborative business processes. Its goal is it to define a language based on WSDL 2.0, describing a peer-to-peer global model for cross-enterprise interactions (collaborations) and their semantics through the composition of web services independent of any specific programming language [33]. Using WSCDL [32], contracts can be produced containing a 'global' definition of the common ordering conditions and constraints under which messages are exchanged. Choreographies describe the common and complementary observable behavior from a global viewpoint of the parties involved.
- **WfMC:** In the WfMC's BPM Reference Model an overall process is seen as a combination of process 'fragments' which can be combined in various ways to deliver new or modified business capability [15]. An internal view defines the actual or intended in-

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<sup>4</sup> In an orchestration the process flow is always controlled by a single party; i.e. in most cases by the service or process component described. (see [3])

<sup>5</sup> Choreography describes processes in a more collaborative way, modeling the sequence of messages, where no party owns the conversation by controlling the process flow. (see [3])

ternal behavior of the process fragment, while an external view defines the behavior of the fragment as a ‘black box’, seen from the outside and addressed through its interfaces. According to [15], choreography is required to identify the valid sequences of messages between the participating process fragments (taken into account by CPs). A choreography requires each process fragment to exhibit a set of prescribed external behaviors (PuPs), which is derived from the internal process behavior (PrP) but represents only the subset that is chosen by the process owner to be made externally visible.

#### 4.4. Other Framework Criteria

Beneath the two core criteria, Level of Abstraction and Modeling of Business Processes, the classification framework provides three additional criteria: Notation, Standardization and Tool-Support.

*Notation:* The criteria notation identifies, which kinds of notation a business process modeling language or approach does support. This could be for example a textual or graphical notation. Furthermore it is described whether the notation is provided by the specification of the modeling language or approach itself, or the notation is not part of the specification and defined otherwise.

*Standardization:* The criteria standardization identifies, whether a modeling language or approach has been standardized by a standardization organization or not. As classification value the respective standardization organization is depicted.

*Tool-Support:* Whether the modeling language or modeling approach is support by (modeling) tools is depicted in the Tool-Support criteria.

### 5. Application of the Categorization Framework

In this section the categorization framework is first applied to selected modeling languages and approaches. Second it is described how the results of the classification can be applied to the development of CBP methodologies. The example introduced in chapter 3.2 will be picked up and extended with the new results.

#### 5.1. Classification of Modeling Languages and Approaches in the Framework

The classification of modeling languages and approaches for business process modeling is shown in table 1. The columns are divided into the classification criteria of the categorization framework. In the rows

we can find the modeling languages and approaches that are classified. In the cells the value(s) of the classification criteria that apply to the modeling language or approach are shown. For the criteria ‘Modeling of Business Processes’ the process types of the categorization framework which correspond to the concepts of the modeling approach are depicted in brackets.

- ARIS [1][13]: ARIS is commonly used for specifying the business view on business processes and therefore for modeling CIMs. ARIS supports a private view on process flow modeled by event-driven process chains. Process modules are used for modeling a public view, while process module chains can be applied for modeling collaborative processes. ARIS provides a graphical notation and large number of enterprises use the ARIS-toolset for modeling their processes with ARIS, though ARIS is not standardized by a standardization organization.
- BPDM [11][16]: BPDM as metamodel specifies concepts for business process modeling at platform independent level. It defines operational, abstract and collaborative processes like in the categorization framework. As a metamodel BPDM does not define a graphical representation of its concepts. Since BPDM is still under submission at the OMG the implementations of BPDM are still in flux. Tools able to read metamodels like the Eclipse Modeling Framework [9] will enable use of BPDM.
- BPML [6]: BPML, as a language for the description of private processes specific to every partner, addresses modeling of abstract and executable processes. It is issued by BPMI.org and its specification defines a XML syntax but no graphical notation [6]. Though some implementations exist, formerly strong supports like SAP decided to support other languages like WSBPEL.
- BPMN [7]: Since the primary goal of BPMN is to provide a notation that is readily understandable by all business users it is used for modeling CIMs. BPMN defines concepts corresponding to the private, public and collaboration processes of the categorization framework. Issued by BPMI.org, BPDM also provides a graphical notation. About 20 modeling tool implementations support BPMN.[8]
- ebXML BPSS [28]: ebXML provides an XML-based specification addressing collaboration protocol agreements for a technology specific infrastructures [27]. Standardized by UN/CEFACT and OASIS it is used at platform specific level. Though the ebXML BPSS specification has also a UML metamodel, it defines only a XML-representation for ebXML BPSS instances [28]. Some of the various tools implementing and supporting the ebXML standard are actually free available. [10]

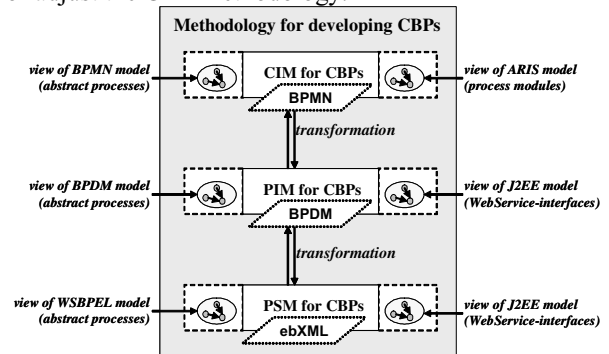
**Table 1: Classification of modeling languages and approaches**

	Level of Abstraction	Modeling of Business Process	Notation	Standardization	Tool-Support
ARIS	CIM	PrP (EPCs) PuP (process modules) CP (process module chain)	provides graphical notation	---	ARIS-toolset
BPDM	PIM	PrP (operational proc.) PuP (abstract proc.) CP (collaborative proc.)	no textual or graphical notation specified graphical notation possible (i.e. UML)	OMG (in progress)	---
BPML	PSM	PrP (executable proc.) PuP (abstract proc.)	textual notation specified	BPML.org	some implementations
BPMN	CIM	PrP (priv. business proc.) PuP (abstract proc.) CP (collaboration proc.)	graphical notation specified	BPML.org	about 20 implementations
ebXML BPSS	PSM	CP (business transactions)	textual notation specified	UN/CEFACT OASIS	various implementations
WSBP	PSM	PrP (executable proc.) PuP (abstract proc.)	textual notation specified graphical notations available (UML-profile)	OASIS	various implementations
WS-CDL	PSM	CP (choreography)	textual notation specified	W3C	---
J2EE	PIM, PSM	PrP (implementation of service components) PuP (e.g. WS-interfaces)	no textual or graphical notation specified graphical notation possible (i.e. UML)	(Sun)	J2EE is basis of many leading web systems software platforms

- WSBPEL [21]: In WSBPEL executable business processes model actual behavior of a participant in a business interaction. Abstract processes specify the mutually visible message exchange behavior of each of the parties involved in a business protocol. The specification of WSBPEL only defines a notation based on XML but e.g. UML-profiles defining a graphical representation. WSBPEL has been adopted by OASIS and various tool implementing WSBPEL exist. [4]
- WS-CDL [32]: WS-CDL is a technical standard of the W3C, providing a XML-based language for the description of peer-to-peer collaborations from the viewpoint of an external observer. In choreographies those message interactions between participants with no central control are described. Neither a graphical representation nor special tool-support does exist yet.
- J2EE [17][18]: Though Java 2 Platform Enterprise Edition (J2EE) is not primarily designed for business process modeling, we classify it in the categorization framework since it supports SOA and is often used to realize enterprise application systems including the implementation of business processes. J2EE, owned by Sun but defined in collaboration with other leading vendors including IBM, Oracle and BEA, is a standardized set of infrastructure software components. Today, it forms the basis of many of the leading web systems software platforms, including IBM WebSphere, BEA WebLogic, Sun ONE and open-source JBoss.

## 5.2. Application for Methodology Development

In section 3.2 it was difficult to determine appropriate modeling languages for the models of the CBP methodology. We formulated two questions we would have liked to be answered in order to improve the choices of modeling languages and concepts for the CBP methodology. In this section we take up the example of section 3.2 and show exemplarily how the categorization framework of chapter 4 and the classification of modeling languages and approaches (section 5.1) can help to answer those questions and to develop or adjust the CBP methodology.

**Figure 2: CBP methodology**

For the CBP methodology an appropriate modeling language or approach to model CBPs in CIMs is needed. This means for the categorization framework, that the criteria Level of Abstraction must have the value CIM and that an appropriate modeling language or approach needs to provide concepts for collaboration processes. Two modeling languages meet these two criteria in table 1: ARIS and BPMN. Since BPMN is standardized, we chose BPMN for modeling CBPs.



Second the concepts of CIMs, specific to the enterprises A and B and provided by views to the development of the CBP have to be identified. The classification of BPMN and ARIS in the categorization framework shows, that in BPMN *abstract processes* and in ARIS *process modules* relate to the concept *public process* and can be provided by views to the development of the CBPs. The views provide a representation of the enterprises public processes, compatible to the representation of public processes of the modeling language or approach used for modeling the CBP. In the case of the CIM process modules of enterprise B's ARIS model would have to be mapped to abstract processes of BPMN representation. Since enterprise A uses the same modeling language as the CBP methodology, providing the view would be an identical mapping of public process representation. (see figure 2)

Like already mention in chapter 3.2 the proceedings to identify appropriate modeling languages and approaches for PIMs and PSMs, is analogous to the described proceeding for the CIM.

## 6. Conclusions and Outlook

This paper illustrates how modeling collaborative business processes can be integrated in the software engineering process. To facilitate this, it provides a categorization framework to modeling languages and approaches for business processes in a service-oriented environment. After classifying a selected set of modeling languages and approaches it shows, considering an example, how the classification information can be used to identify the appropriate modeling languages, approaches and concepts for the various models and artifacts of CBP methodologies.

Future work will be to define views of modeling languages, which can be used for the development of CBPs. Enriching the various models with semantic information, defined by cross-enterprise ontologies, will help to integrate those models. Also the development of methodologies for collaborative business processes, able to be adjusted to particular project requirements, will be an important task.

Related work, categorizing business process modeling languages, can be found in [15] and [24].

## 7. References

- [1] Adam, Hofer, Zhang: Cross-Enterprise Business Process Management Architecture – Methods and Tools for Flexible Collaboration, MIOS p.483. 2004.
- [2] Bauer, Müller: Methodologies and Modeling Languages, in Agent-Based Software Engineering, Artech House, 2004.
- [3] Bauer, Müller, Roser: Adaptive design of cross organizational business processes using a model-driven architecture, 7. Internationale Tagung der WI, 2005.
- [4] BPEL Resource Guide, <http://www.bpelsource.com>.
- [5] BPMI.org: Homepage, <http://www.bpmi.org>.
- [6] BPMI.org: Business Process Modeling Language, 2002.
- [7] BPMI.org: Business Process Modeling Notation (BPMN) – Version 1.0, Specification 3-5-05, 2004.
- [8] Business Process Modeling Notation (BPMN) Information, [http://www.bpmn.org/BPMN\\_Supporters.htm](http://www.bpmn.org/BPMN_Supporters.htm).
- [9] Eclipse EMF: Homepage, <http://www.eclipse.org/emf/>.
- [10] ebXML Homepage: <http://www.ebxml.org>.
- [11] Frank, Gardner, Johnston: Business Process Definition Metamodel – Concepts and Overview, IBM, 2004.
- [12] Gardner, Griffin, Koehler, Hauser: A review of OMG MOF 2.0 Query / Views / Transformations Submissions and Recommendations towards the final Standard.
- [13] Griebble, Klein, Scheer: Modellbasiertes Dienstleistungsmanagement, Heft 171, Juli 2002.
- [14] Harmon: The OMG' Model Driven Architecture and BPM, in Business Process Trends, Volume 2 No. 5, 2004.
- [15] Hollingsworth: The Workflow Reference Model – 10 Years On, The Workflow Handbook 2004 p. 295-312, 2004.
- [16] Iyengar et al. Business Process Definition Metamodel. Revised Submission to BEI RFP bei/2003-01-06. 2004.
- [17] Java 2 Platform, Enterprise Edition (J2EE), Sun, <http://java.sun.com/j2ee/>.
- [18] Loosely Coupled Glossary, <http://looselycoupled.com/glossary/J2EE/>.
- [19] OASIS: Homepage, <http://www.oasis.org>.
- [20] OASIS: Electronic Business Service Oriented Architecture, Working Draft 047, August 2004, 2004.
- [21] OASIS: Web Service Business Process Execution Language Version 2.0, Working Draft December 2004, 2004.
- [22] OMG: Homepage, <http://www.omg.org>.
- [23] OMG: MDA Guide Version 1.0.1, OMG, 2003.
- [24] Peltz: Web service orchestration, a review of emerging technologies, tools, and standards, 2003.
- [25] Scheer. ARIS: Modellierungsmethoden, Metamodelle, Anwendungen, Springer 1998.
- [26] United Nations / Centre for Trade Facilitation and Electronic Business: Homepage, <http://www.unece.org/cefac/>.
- [27] UN/CEFACT: UN/CEFACT Modeling Methodology (UMM) User Guide, V20030922, 2003.
- [28] UN/CEFACT: ebXML Business Process Specification Schema, Version 1.09, 2003.
- [29] Vallecillo: RM-ODP: The OSI Reference Model for Open distributed processing.
- [30] WfMC: Homepage, <http://www.wfmc.org>.
- [31] W3C: Homepage, <http://www.w3c.org>.
- [32] W3C: Web Service Choreography Description Language Version 1.0, W3C Working Draft 12-10-04, 2004.
- [33] W3C: Web Services Choreography Requirements, W3C Working Draft 11-03-04, 2004.