Strategy, Model, and Platform for Collaborative Commerce

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Abstract

Globalization and rapid development of Information Technologies have set a new stage for business. Collaborative Commerce has become a strategic necessity to develop high quality products at low cost and with quick response times to market demand. This paper proposes an integrated solution for CC including the collaborative strategy, model and platform. The reference processes and strategy of CC is derived using a structural top-down analysis approach. According to the analysis and abstract of collaborative commerce behavior, the collaborative meta-model is put forward to support the description of complex collaborative relationship in CC environment. On the foundation of collaborative meta-model, the collaborative model of CC can be established. Finally, the SOA and MDA based platform for CC is developed to enable value-added collaboration between partners by providing new technical solutions, best practices, and collaboration tools. The platform represents a virtual, model-driven and service-oriented integration environment accessible to the involved companies within a heterogeneous IT-infrastructure.

1. Introduction

With the rapid development of business environment and distributed global organization, business processes of enterprises need to meet the new business requirement. In order to finish their own businesses, enterprises have to collaborate with other enterprises and organizations to face the global competition. Furthermore, the advancement of information technology has set a new stage for manufacturing. One strategy for enterprises to succeed in this environment is Collaborative Commerce (CC). In this paper, CC is defined as: ‘‘an Internet based computational architecture that supports the sharing and transferring of knowledge and information of the product life cycle amongst geographically distributed companies to aid taking right decisions in a collaborative environment’’ [1]. The main goal of CC is to integrate and leverage knowledge, technologies, and resources among all the collaborators.

Over the last decades, numerous efforts have been made in the area of CC. Most of them focus on technical aspects. More recently, SOA and MDA have emerged as a major evolutionary step in CC area. The MDA and SOA represent the current best-practice in how to develop new software and how to recondition legacy applications in order to design collaborative systems.

In this paper, an integrated solution based on MDA and SOA is proposed to support the design and implementation of CC system. Firstly, the reference processes and strategy of CC is derived using a structural top-down analysis approach. And then, according to the analysis and abstract of collaborative commerce behavior, the collaborative meta-model is put forward to support the description of complex collaborative relationship in CC environment. On the foundation of collaborative meta-model, the collaborative model of CC can be established. Finally, the SOA and MDA based platform for CC is developed to enable value-added collaboration between partners by providing new technical solutions, best practices, and collaboration tools. The platform represents a virtual, model-driven and service-oriented integration environment accessible to the involved companies within a heterogeneous IT-infrastructure.

2. Related Work

The research works in CC area include business and IT aspects. In business aspect, the research works mainly focus on cross-organizational business process integration. In IT aspects, the MDA and SOA represent

the current best-practice in how to develop new software and how to recondition legacy applications in order to develop CC systems.

2.1. Cross-Organizational Business Process Integration

Rapid technological advances and altering customer demands create a new dynamic and complex business environment. For these reasons different enterprises have to cooperate in order to encounter the contemporary prevalent high competition [2].

Research on business aspect of CC is mainly concerned with networked organizations and value models. Important scientific contributions to business collaboration have come from transaction cost theory, organizational theory, coordination theory, and business networks. Christine Legner derives the relevant artifacts and proposed a comprehensive business collaboration framework to address the interactions between business strategy, organizational design and information system design [3].

For CC, business process model and integration are the cores of business collaboration. Currently, multi-views business process model [4, 5] is used to describe business requirement in collaborative environment. It mainly includes five parts: the process view, organization view, resource view, function view and information view. Process view is the most important and basic part and the integration core of other views. The description of business process model general starts with process definition. On the basis of process model, through the complementation of information that is transferred between activities, execution role of activity, allocation rule of resource that activity needs and etc, we can get an integrated business process model. This model can describe aspects of characteristics of enterprise accurately and fully. So it is the necessary foundation to find correlation between process elements and actualize collaborative management in the final to build such enterprise business process model and further optimize it.

2.2. SOA and MDA based CC system

Over the last decade numerous efforts have been made in the area of CC. Most of them focus on IT aspects. More recently, SOA and MDA have emerged as a major evolutionary step in CC area.

The World Wide Web Consortium (W3C) refers to the service-oriented architecture (SOA) as ‘‘a set of components which can be invoked, and whose interface descriptions can be published and discovered’’ [6]. As an architectural style for distributed systems, SOA have been gaining momentum over the last few years and are now considered as mainstream in enterprise computing. Compared to earlier middleware products, SOA put a stronger emphasis on loose coupling between the participating entities in a distributed system. The four fundamental tenets of Service Orientation capture the essence of SOA: explicit boundaries, autonomy of services, declarative interfaces, data formats and policy-based service description [7]. SOA allows enterprises to dynamically publish, discover and aggregate a range of Web services through the Internet and offers mechanisms of flexibility and interoperability that allow different technologies to be dynamically integrated, independently of the system’s platform in use. The most frequently used method for implementing SOA is Web Services. W3C specifies that web services are “applications identified by a URI, whose interfaces and bindings are capable of being defined, described and discovered as XML artifacts. A Web service supports direct interactions with other software agents using XML-based messages exchanged via Internet-based protocols [8]”. Web services are not single but a collection of a variety of technologies offering services’ description, registration, publication and search functionalities [9]. Figure 1 provides an overview of existing Web service specifications organized in terms of the issues that they address.

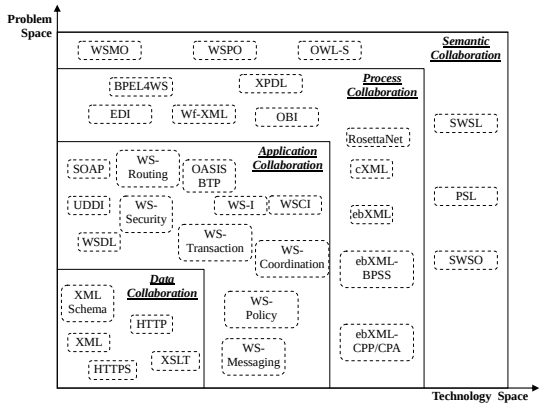

Fig. 1. Overview of the Web services stack

Although providing a significant contribution, the SOA alone is not yet the answer to achieve CC. Some crucial problems still related with the implementation of CC in SOA environment, such as development methodology, the dynamic combination and usage of services, the consistency between business and information system.

Model-Driven Architecture (MDA) is a best choice to address how SOA and Web services should be

designed, developed and integrated in order to achieve collaboration. MDA is proposed by the Object Management Group (OMG) as a reference to achieve wide interoperability of enterprise models and software applications [10]. MDA provides specifications for an open architecture appropriate for the integration of systems at different levels of abstraction and through the entire information systems' life-cycle. The MDA comprises three main layers: Computation-Independent Model (CIM), Platform-Independent Model (PIM), Platform Specific Model (PSM) [11]. MDA lies in separating the enterprise model from the technology infrastructure, making a clear division between the business functions and the implementation details. When a requirement changes the business behavior, this change is reflected in the abstract level (i.e., PIM) and it will be directly mapped to the system through the PSM. Hence, the enterprise model is transformed to be applied to different technology deployments like J2EE or .NET.

Integrating SOA with MDA gives the opportunity to bring the SOA to a higher level of abstraction, adding agility, flexibility, due to the more formal and accurate platform-independent specification of the services requirements and design.

3. Reference processes and strategy for CC

In order to derive all the necessary business objectives that enterprise users must achieve in CC processes, a structural top-down analysis approach is used. The approach started with the overall objective of CC, i.e. to collaborate with other enterprises based on core competence and economic benefit, therefore, to be able to quickly delivery high quality product to customers with low cost. In general, the objectives of enterprises utilizing CC fall into three categories: seeking collaboration opportunities by publishing their products and/or services, outsourcing some engineering tasks by selecting suitable collaboration partners, and performing engineering collaboration with the partners. From the perspectives of enterprises, the overall objective is broken into more tangible objectives that can be realized in certain stages of the whole collaboration process. Within this paper, the overall objective is realized in two stages, i.e. the earlier phase of the collaboration process and the later phase of the collaboration process. The respective objectives of the two stages are:

- To facilitate the establishment of OEM-supplier or joint venture collaborative relationships
- To facilitate engineering collaboration, such as collaborative product design and manufacturing.

The two stages are referred to as the medium-level objectives in the structural analysis approach. The medium-level objectives are further broken into detailed-level objectives, which can be realized through the execution of the respective business processes. The reference process for CC is illustrated in figure 2.

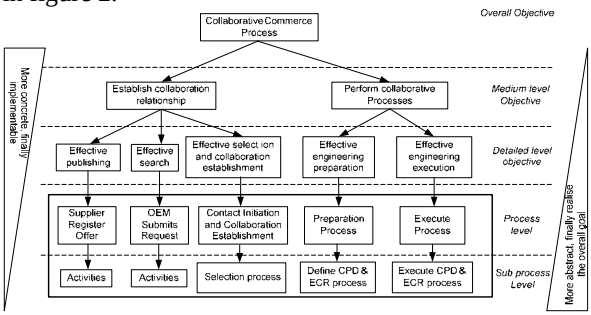

Fig. 2. The reference processes for CC

In order to support the implementation of the above mentioned objectives, the strategy for CC is proposed to provide an overall framework to enable common, tightly integrated collaborative processes between distributed companies based on given IT-technologies and software tools as well as Internet technologies [12]. Figure 3 shows the conceptual architecture of the strategy. Five basic requirements in CC were addressed in the strategy:

Fig. 3. Strategy for Collaborative Commerce

1) Locate collaboration partners in markets, to initiate contact and to establish a collaboration,

2) Support the dynamic integration of collaborative processes based on consistent information models,

3) Support the handling, visualization and validation of information,

4) Facilitate a requirement driven collaborative process, and

5) Identify and solve problems caused by cultural differences.

4. Collaborative Model for CC

In CC environment, business collaboration mainly refers to four elements: process, role, service and data. According to the difference of main bodies taking part in collaboration, collaboration can be classified into collaboration between process and process, process and service, service and services, role and role, role and process, role and service, data and data and etc, as illustrated in Fig. 4.

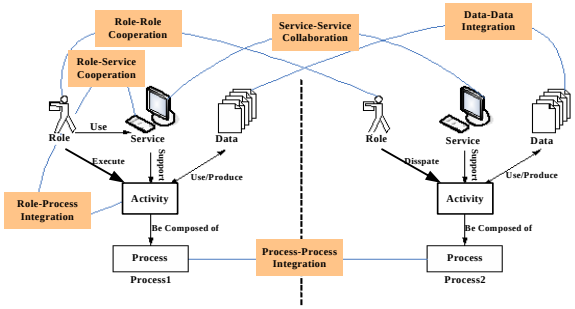

Fig. 4. Collaborative relationship in CC

1) Collaboration between process and process: Cross-organizational collaboration usually can be realized in the form of business collaboration. The collaboration between business activities can come down to inter-process collaboration finally.

2) Collaboration between data and data: There are large numbers of heterogeneous data (database, XML, file and etc) in enterprise. In order to ensure inter-enterprise information share and transformation, data integration should be considered.

3) Collaboration between role and role: In enterprise business collaboration, the cooperation between roles is multi-levels. On the one hand, enterprises that can act different business roles finish altogether each business role taking on in the process of business collaboration. On the other hand, person and enterprises taking on different roles finish the same external service altogether. Obviously, this kind of collaborative process includes communication and collaboration among persons.

4) Collaboration between service and service: In SOA-based collaborative environment, in order to achieve mutual access and inter-enterprise transfer of business function, business achievement should be encapsulated into service and is shared and integrated in collaborative service bus. It can be used to support inter-business process collaboration and inter-role collaboration.

The above analysis shows that the relationships among cross-organizational business cooperation are anfractuous.

In this paper, according to the analysis and abstract of collaborative commerce behavior, the collaborative meta-model is put forward to support the description of complex collaborative relationship in CC environment. On the foundation of collaborative meta-model, the collaborative model of CC can be established, which consists of six sub-models: process sub-model, event sub-model, role sub-model, service sub-model, data sub-model and state machine sub-model.

The collaborative model has some new characteristics in contrast to other business process modeling methods. Firstly, it is composed of process, role, service and data. Secondly, it can describe and support the complex collaboration relationship existing in business process. Thirdly, business function and achievement are encapsulated into services. Furthermore, it reflects business requirement of enterprise. These characteristics indicate that collaborative business process model can well support cross-organizational business process integration in SOA-based collaborative environment and solve the modeling problem existing in current cross-organizational business process integration.

5. Web Service Platform for CC

In this paper, a web service based platform for CC is developed and implemented. The platform represents a model- and service-oriented integrated environment accessible to the involved companies within a heterogeneous IT-infrastructure. The platform serves as a central point of access to a (virtually) common CC process model and allows collaborating partners to share product information stored in various application systems transparently via the Web. The use of modern technologies, i.e. web service and workflow, enables not only the information collaboration from IT perspective, but also the process collaboration from business perspective.

As shown in figure 5, four major layers are identified in the platform's architecture: application service layer, infrastructure layer, collaboration service layer, and UI (user interface) service layer.

1) The application service (AS) layer provides functionalities to access proprietary information sources of the enterprises involved in a collaboration, like PDM-systems, ERP-systems, etc. The connection

between platform and the application systems is realized with SOAP. Therefore an adapter must be implemented for every application, which assumes the mapping between the enterprises' applications and SOAP.

2) The Infrastructure Service (IS) layer: The infrastructure layer provides the basic data service and integration service for CC. All data flows within platform are supported by the infrastructure. The data service manages distributed data sources and offers a transparent view on the data for the platform services. The integration service provides the interaction mechanism between platform components. In order to provide these functionalities, the infrastructure has to provide functions/services to manipulate the data. These services could either rely directly on the meta data model or use a more high level business context. The Integrated Domain Data Models are derived from the meta data model and contain the data object types which are required by the business services provided by the components. The infrastructure provides the basic access function to data and components according to the meta data model and/or according to the integrated domain data model. The meta data model interface and the integrated domain data model interface together represents the data interface. This interface is accessible through Web Services, i.e. it provides the functionalities of the data service through a WSDL-based interface for mandatory use by any of the business services.

3) The collaboration service layer provides the specific collaboration services. According to the CC strategy mentioned in section 3, five basic collaboration components are provided by the platform in form of service:

- Request & Navigation Component (RNC): The Request and Navigation Component offers functionalities to find a relevant partner, initiate contact with the found partner, and establish collaboration by defining universal conditions and arranging competences and responsibilities.
- Check of Collaboration Partners Component (CCP): The Check of Collaboration Partner component is utilized to support the collaboration initiation phase of CC. It is divided into three services: partner matching, evaluation of Matching Results, and evaluation of Offers during Negotiation.
- Process Management Component (PMC): The Process Management Component provides functionalities for modeling and executing the CC processes. The process models are saved in the portal in a certain process definition format, which can be interpreted by the workflow engine, which coordinates the execution of these business processes.
- Specification Modeler Component (SMC): The Specification Modeler Component lets users define and manage a necessary and sufficient subset of product requirements. It further provides functionality for the checking of consistency and completeness of requirements and product properties. It is also involved in the early phases, when initial product requirements are formulated and when requirements on potential partner companies are defined. The data is only shared by involved partners.
- Visualization & Validation Component (VVC): The Visualization & Validation Component allows users to define different views on engineering data and to validate the data. The data is only shared by involved partners.
- Cultural Repository Component (CR): In order to override the problems in collaborative processes between distributed companies caused by different cultural backgrounds and differences in language and education, a cultural repository is foreseen. Its functionality is going beyond simple request-based advisory systems and literature databases. It also intends to survey ongoing processes on the portal and intervene when necessary.

4) UI service layer: In platform, the service-specific UI service and generic UI service will be provided for browsing available information resources or navigating through networked data structures. The UI services interact with the other services via HTTP or SOAP.

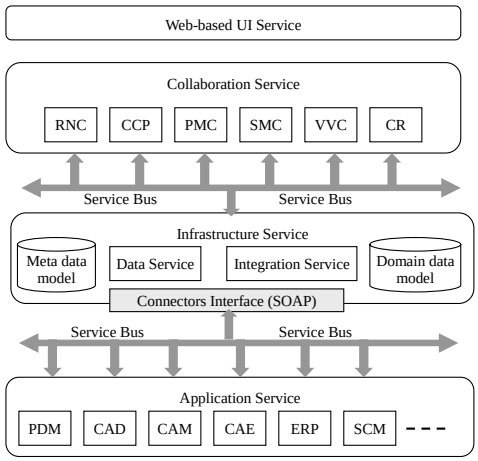

Fig. 5. The architecture of CC platform

6. Scenario validation for engineering portal

The scenario selected in this paper is about the collaborative development of a new variant of a car in Mercedes-Benz. There is an existing type: Mercedes-Benz "A-Class A 210". The new variant should be bullet proofed. Only parts, concerning the bullet resistance have to be modified. In this scenario only the left rear door is modified. The scenario demonstrates the whole development process beginning with the search for a new supplier for a window motor and ending with a certified prototype of a bullet proofed. Table 1 shows the stakeholders in this scenario.

The scenario contains the following general steps:

1) User login and registration,
2) Search for a new supplier, matching of possible suppliers,
3) Sign the contract,
4) Define a new product by using a template,
5) Definition of initial requirements,
6) Consistence check,
7) Start of the development process
8) Definition of detailed requirements,
9) Consistence checking, CAD visualization
10) Data exchange (using the security tool for CAD data, DMU, simulation)
11) Testing, release,
12) End of collaborative project

Tab. 1. Stakeholders in the scenario of Benz

Shortcut	Name	Description
OEM	Mercedes-Benz	Development of the whole car, management of the suppliers and development partners.
SUP 1	Car Engineering Solutions	Development (design) of the modified door, including the window glass.
SUP 2	Electric-Motor-Corporation	Supplier of the window motor.
BOA	Shelling Office	Official institution, tests the new guard variant, before it gets the sign of authorization to be called "bullet proofed". They also provide guidelines to reach the authorization.

* OEM: Original Equipment Manufacturer. SUP: Supplier. BOA: Official Board

Several components of the platform are used to support the implementation of the scenario. Table 2 shows the contributions of the platform components in the scenario.

Tab. 2. The contributions of the platform components

Name	Phase	Description
IS, UI	SP, CE, CPD	Showing and handling of the distributed data (Requirements, CATIA V5-files, pictures, "pdf" and "Word"-documents). Integration of the portal components.
RNC	SP, CE	Search for a new supplier for the window motor.
CCP	SP, CE	Locating of a new supplier for the window motor.
PMC	CPD	Modelling and Management the development processes between the project partners.
VVC	SP, CE, CPD	Visualisation of the CAD model and data (product requirements, pictures, "pdf"- and "Word"-documents).
SMC	SP, CE, CPD	Definition of the initial (process and product) and detailed requirements, use of templates, consistency check of the requirements including an automated generating of new requirements, interactions between OEM and Supplier according the requirements.
CR	SP, CE, CPD	Notification of the users about differences between some countries according norms and laws.

* SP: Searching Partner, CE: Collaboration Establishment, CPD: Collaborative Product Development

6. Conclusions

Enterprises are driven by the world market to seek global engineering opportunities, which can be for example joint ventures, subsidiaries or relations with foreign suppliers. In order to ensure an efficient and reliable partnership with cooperators in distributed environments, the common strategy, model and platform of collaboration must be developed. The research results of this paper enable the collaborative commerce by providing the common CC processes, strategy, and the new technical solutions for the collaborative platform. The activities and business processes supported by the platform cover the full life cycle of CC, from the searching of potential partners, establishing collaboration to the engineering collaboration. Through the scenario validation, the platform can effectively support the whole processes in CC. Both manufacturer and supplier are enabled to collaborate via the platform. The main features and functions of the platform include:

1) Provide a single Engineering Portal based on Internet technologies that supports multi-cultural collaboration partnerships

- Find appropriate, and evaluate potential suppliers/engineering partners in different cultural areas.
- Initiate contact to potential multi-cultural partners based on a Cultural Repository and a repository of Best Practices.

- Establish a common computer-aided engineering process, safeguarding each partner's intellectual property and considering cultural characteristics.

2) Interconnect heterogeneous systems based on web service

- The individual partner's data are shared over the engineering portal.
- The partner's individual engineering processes are linked together to a comprehensive, and integrated supply chain.
- Provide mechanisms to define classified (or unnecessary) information in order to hide information.

3) Realizing a model and service driven engineering collaboration

- Providing methods and tools for process modeling and execution as a basis for the engineering collaboration.

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