Ontologies-Based Business Integration

Michael Rebstock · Janina Fengel · Heiko Paulheim

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With Additional Contributions by
Christian Huemer, Klaus-Dieter Naujok,
Patrick Röder and Omid Tafreschi

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Prof. Dr. Michael Rebstock
Janina Fengel, MSc
Heiko Paulheim, BSc

Faculty of Economics
and Business Administration
Darmstadt University of Applied Sciences
Haardtring 100
64295 Darmstadt
Germany

rebstock@fbw.h-da.de
fengel@fbw.h-da.de
paulheim@fbw.h-da.de

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Preface

E-business integration is a vision we have developed over a long period of time. As we have worked in business practice for many years prior to and in parallel with our academic research, we have always thought of such integration not only as an intellectual challenge but also as a real business tool. Consequently, when we started our project on Ontologies-based Reconciliation for Business Integration (ORBI) in 2004, not only pure science but also business objectives were at the center of our research. We were very happy to be able to form a project consortium that consisted not only of renowned researchers but also of experienced business practitioners from a range of companies. Each played a specific role – as user, provider or co-developer of the application components that are based on the methods we have developed.

So may this book find its way not only to the desks of researchers and students, but also into the offices and minds of business practitioners worldwide who are dealing with the challenge of integrating their business processes, applications and information.

This book is, in the most general sense, about understanding each other – that is, what we do and think. Needless to say, within the project itself, and its environment, we had many opportunities to apply this underlying philosophy. In the end, the results prove it was worth the effort.

The book and the research it reports would not have been possible without the help and support of many people and organizations. We want to thank all of them for what they did for our work.

First, there are the present and past members of the ORBI project consortium. The academic partners include Gerhard Knorz from Darmstadt University of Applied Sciences, Martin Minderlein from Ansbach University of Applied Sciences, Michael Herfert and Ruben Wolf from Fraunhofer Institute for Secure Information Technology, Omid Tafreschi from Technische Universität Darmstadt, and Carlo Simon from University of Koblenz-Landau. The business partners include Boris Reuter from axentiv, Dietrich Jäger from i-market, Thomas Kummler und Mirko Doninger from Krombacher Brewery, Hubert Stockmeier from SupplyOn and Jan Matthes from EMB. Special thanks go to Klaus-Dieter Naujok and Christian Huemer from UN/CEFACT's and OASIS' joint former ebXML project as well

as to Patrick Röder and Omid Tafreschi from Technische Universität Darmstadt, who agreed to contribute chapters to this book.

Our research was supported by many present and past student assistants and master's students. We want to thank all of them, especially Margrit Schaede who prepared the data for the system evaluation as well as Elzbieta Wieczorek and Martin Osuch who have helped to prepare the manuscript. Special thanks also to Martin Düpré for his technical support and to Melissa Nelson for proofreading.

We would like to thank the German Federal Ministry of Education and Research for the research grant that made this project possible. We are also grateful to the people both at AiF – especially Petra Mueser and Norbert Esser – and at Darmstadt University of Applied Sciences' Center for Research and Development – especially Ute Jochem – for their administrative support of the project.

We thank all the people at Springer who have helped to make this book possible. Special thanks to Ed Schuster from MIT for publishing the book in his Data-Driven Economy series.

Finally, a very big thank you to our families and partners who – especially in the last months – have endured seeing us even less than they normally do.

Darmstadt, November 2007

Michael Rebstock
Janina Fengel
Heiko Paulheim

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List of Additional Contributors

Klaus-Dieter Naujok
Former ebXML Chair
Illumonus, LLC
Founder and CEO
4410 Deermeadow Way
Antioch, CA 94531, USA
klaus@illumonus.com

Prof. Dr. Christian Huemer
Institute of Software Technology and Interactive Systems
Vienna University of Technology
Favoritenstrasse 9 – 11 / 188-3
A - 1040 Vienna
huemer@big.tuwien.ac.at

Patrick Röder
Omid Tafreschi
Technische Universität Darmstadt
Fachbereich 20 FG Sicherheit in der Informationstechnik
Hochschulstrasse 10
D - 64289 Darmstadt
roeder@sec.informatik.tu-darmstadt.de
tafreschi@sec.informatik.tu-darmstadt.de

1 Coping with Semantic Variety in E-Business

The globalization of everyday business and increasing international trade are leading to a growing need to improve national and international business collaborations and transactions. Emerging technologies for e-business transactions allow for new methods of process, data and application integration. Thus, business processes today commonly require electronic transactions between business partners. With the general objective of seamlessly coupling electronic information chains, process, data and application integration have become a major challenge in sustaining international trade and business development.

1.1 Semantic Variety and Ambiguity

Business partners almost always have different ways of systemizing the information needed to run a business, in terms of information syntax, structure and semantics. A growing number of these systemizations are based on industry, national or international standards. Currently, numerous e-business standards are already in use, and more are under development. Standards can be document standards, product taxonomies, business process blueprints and more, which differ in content, structure and methodology. In most business relationships, several of these standards are used at the same time, in parallel, within electronic collaborations and on electronic markets.

We term this ubiquitous, heavily parallel use of standards in electronic collaborations *semantic variety*, as it not only generates different syntactical requirements, but also, more importantly, creates the challenge of understanding the *meaning* of a business partner's messages. The consequences of semantic variety are mismatch and misunderstanding in electronic transactions, what we term *semantic ambiguity*. Too often, this results in the disruption of the electronic information chain and thus leads to negative cost, time and quality effects.

Semantic ambiguity in electronic transactions can occur on both the *schema level* and the *content level* of an electronic transaction. On the

schema level, a data field "Terms of Delivery", for instance, can raise different expectations. Besides the question, in which format or syntax the field has to be encoded, it is substantial to know what information exactly should be transported in it. Is a statement wanted (only) about insurance and freight cost handling – or also about the mode of transport, about delivery time and schedules, about cold storage maybe? Then, on the content level, it has to be clear what entries are accepted for this field, and whether it is necessary to standardize this information, e.g., as foreseen by UN/EDIFACT (UNECE 2006). Using the standardized term "FOB Shanghai", for instance, would express that the seller cares for the delivery of the goods until they pass the ship's rail in the port of Shanghai. But can we be sure about the business partner's expectations without prior consultation?

We expect that semantic ambiguity will persist. At least three trends are driving the continuous development of new standards and thus hindering a convergence of standards towards a single one. These trends are new technologies, changing business processes and the globalized economy.

Although it might be expected that advances in technology and e-business application development result in a unification of standards, the opposite is the case. Before the advent of the commercial use of the Internet, at the beginning of the 1990s, it was expected by many that within a few years EDIFACT would be the general standard for electronic data interchange (EDI) communications. With the Internet, the Web and the Semantic Web, layers as well as scenarios of business communication multiplied, resulting in a need for new tools and standards. A large number of consortiums or companies have started projects in recent years in response to the challenge of process and information flow integration from different perspectives. UDDI (OASIS 2004), ebXML (ebXML 2007), Biztalk (Microsoft 2005), xCBL (xCBL 2006), BMEcat (eBSC 2005), eclass (eClass 2005), RosettaNet (RosettaNet 2007a), RDF Schema (W3C 2004d) and OWL (W3C 2004e) are some examples. All of these initiatives have contributed to standardization and created a whole new range of application and process possibilities. But this led to classical, EDIFACT-based EDI becoming less and less the standard scenario.

The development of new business process scenarios contributes to the growth of the visible number of standards. First, with the rising number of companies participating in interorganizational process chains, electronic markets and business transactions, an increasing number of once secluded inhouse standards now come into contact with other companies' information structures and content and have to be matched. Furthermore, changing process coordination needs stipulate new standards. Time-sensitive advanced-planning solutions for supply chain management (SCM) scenarios, for instance, call for a tight coupling of shop-floor automation systems

with enterprise resource planning (ERP) applications. Web services further widen the options for these types of business communications and advanced process designs – but also necessitate additional, new standards. For some emerging business application areas, such as electronic negotiations, comprehensive standards are not even fully available.

Within the globalized economy, the business transactions of any company increasingly involve partners from other countries. In some of these countries, specific national or international standards are well established. This exposes companies to the necessity of dealing with the particular standards used by their business partners from abroad. Additionally, some large vendors still believe that establishing their own standards as an industry standard will grant them a competitive edge in the world market. This results in a number of want-to-be industry standards for emerging application areas. Even if many of those vanish over time, some winning standards last. Finally, the globalized economy drives the multiplication of standards at the national level. Evolving major players in the world economy – especially China – have discovered that setting a standard may be a powerful means of gaining economic standing and influence (Suttmeier et al. 2006).

1.2 Research Agenda

Thus the question of how to deal with different document standards, product taxonomies and other norms, all in use at the same time, reaches critical importance in today's world of open electronic communication, especially since these standards use different semantics.

Motivation

The exchange of and close adherence to field lists and formats does not guarantee that the – semantically – "right" fields with the "right" content are transmitted to a business partner. Technical standards or syntactic specifications obviously are not sufficient for semantic harmonization. Consequently and unsurprisingly, despite the hopes of IT managers worldwide, the "wonder-weapon" eXtensible Markup Language (XML) (Bray et al. 2006) did not solve the problem of sufficiently integrating process and information flows, even though it became a general syntactic standard.

How can businesses worldwide cope with the abundance of standards, and how can they achieve semantic interoperability under these circumstances? Past approaches have often been comprehensive. The develop-

ment of and agreement on a universal standard is an often intended aim when dealing with semantic reference systems. Most of the consortiums and initiatives mentioned above subscribe to this aim. For exactly this reason, however, this aim proves impracticable. Other initiatives have tried to create a universal superstandard by merging existing standards into one. But because of the sheer number of existing and evolving standards and their dynamically changing nature, such comprehensive approaches have failed regularly.

Thus, with more and more e-business standards being used concurrently, complexity as well as time and cost requirements for building up electronic collaborations grow. Not only for small and medium-sized enterprises (SME) this fact can hinder the further and full development of electronic business integration, both conceptually and practically.

Approach

The challenge in electronic business transactions is to achieve *semantic interoperability*, i.e., to avoid mismatch and misunderstandings in integrated business processes, taking into account the parallel usage of standards. In this book, we identify *ontology management and engineering* techniques as an appropriate means for meeting these challenges. Information structures and standards for electronic business integration can be perceived as domain ontologies, as they contain domain knowledge in a structured form (Gómez-Pérez et al. 2004). Using ontologies and ontological engineering techniques, *semantic references* between information both on the structure and content level can be established.

The global Semantic Web initiative (Herman 2007) and networks such as OntoWeb (OntoWeb 2003) and its successor Knowledge Web (Knowledge Web 2005) have taken up the question of semantics and ontologies for information integration. The aim of these initiatives is the development of methods and procedures for managing semantic reference systems.

Often, document standards and object taxonomies are created for particular purposes or specific domains, for example the Dublin Core Metadata Element Set for cross-domain resource description (DCMI 2006), or biomedical (NLM 2006; OBO 2007), cultural heritage (Sinclair et al. 2006) and e-commerce focused ontologies. Conceptually, the significance of managing ontologies – meaning semantic reference systems for electronic business collaborations – has been discussed for a while (Gruber 1993a; Domingue 1998; Tennison and Shadbolt 1998). Still, methods and services for the practical use of ontology engineering techniques for e-business integration took much longer to be developed. Now, they have become highly necessary.

As it is very unlikely that companies around the world will simultaneously stop using different e-business standards, an approach that promises success should not try to create another "superstandard," but rather, to achieve semantic interoperability and thus business-to-business (B2B) integration through other means. In our view, this could be done by following an evolutionary, user-centered approach for building a knowledge base of semantic references. A successful approach to manage lasting semantic ambiguity in this sense will show three characteristics: it will be dynamic, evolutionary and based on open virtual communities:

- A dynamic method will accept the coexistence of a multitude of standards with references evolving dynamically and thus allow ongoing adaptation to changing standards.
- An evolutionary approach discards the idea of a complete initial reference base. In a world in which it is unclear where the next standard will originate from, this is a necessity. Moreover, if the complete initial building of a knowledge base is not required, ramp-up costs, and thus entry barriers, for companies wishing to participate in an electronic exchange are significantly lower, which is particularly important for SME.
- A community-based method relies on virtual social systems growing their knowledge base by means of collaborative user interaction and feedback (Almeida et al. 2007). As experiences with automated ontological engineering tools for semantically interlinking different ontologies show, domain expert knowledge is not only beneficial (van Harmelen 2006), but is needed for raising mapping quality to an acceptable level (Zhdanova et al. 2004). A collaborative social system supplies a platform for the necessary learning and quality improvement without raising costs to an unacceptable level.

1.3 Research Objectives

The general objective of the approach developed in our project (ORBI 2007) and presented in this book is to allow ontologies-based integration of e-business processes and information flows. In order to achieve this goal, not only conceptually but also in practice, the development of methods and modular application components for the referencing of e-business standards in electronic collaborations is required. We believe that these results will supply a yet missing but, in terms of application logic, very necessary next step on the way to integrated information and process chains.

In order to achieve the intended integration, several issues have to be considered. These include fundamental questions about the nature of busi-

ness processes and business information flows on the one hand as well as thoroughly analyzed technical options for the necessary application integration on the other. Thus, our research objectives can be summed up as follows:

Establish Semantic Interoperability. In order to ensure a true common understanding about the contents of a communication between business partners, certainty regarding the semantics of the data transferred has to be established. Agreeing upon and deploying a syntax standard is not sufficient.

Enable Seamless Information Exchange. In business communications today it is still not unusual that some information is at times transmitted from one information system into another manually, i.e., by re-typing the data. Often, this is done intentionally in those situations where semantic ambiguity may arise, thus establishing a manual information quality control by a user. Methods for seamless information exchange should be able to refer to sufficient expert knowledge in order to render manual user interfaces unnecessary.

Integrate Business Processes. Many research projects addressing ontology engineering and management in the business area overlook the fact that information is never exchanged on a purpose-free basis, but rather, it always travels along with business processes – i.e., material, financial or coordination flows – and serves their specific objectives. The real purpose of ontological engineering methods in the business area is not information integration itself, but the integration of its underlying processes.

Allow Concurrent Usage of Multiple Standards. Based on their past experience, business practitioners, especially many IT managers, often assume that the ultimate information-exchange strategy is to get all business partners to communicate using the same standard. As argued above, this goal is even more unrealistic today than it was in the past. Modern methods for information integration must allow concurrent usage of more than one standard within electronic collaboration networks without additional implementation requirements.

Integrate Potentially Any E-Business Standard. Many initiatives restrict the range of standards they deal with for political, practical or technical reasons. For companies exposed to different national, industry or enterprise-specific standards – as is practically every business if all of its communications are addressed – this approach is clearly of low practical value. A universally usable methodology will avoid the predefinition of a range of manageable standards.

Supply a Reference Collection as Knowledge Base. Creating references between the elements of different standards means clarifying their semantics in a given context. Once created, this expert knowledge should be available to other users within the same or even other collaboration contexts. Methods for semantic referencing should preserve the knowledge created.

Allow Evolutionary Growth of the Knowledge Base. Establishing a complete reference collection as a knowledge base beforehand is very unlikely due to the number of standards, their evolution speed and the cost a complete analysis would create, if it were at all possible. Thus the knowledge base has to be flexible, in the sense that its evolutionary growth is not only possible but also a substantial building criterion. Clearly, an approach that does not start with a fully developed knowledge base shows weaknesses in the starting phase. Due to its initially small knowledge base, references supplied by the system might be erroneous and incomplete. But with the growth of the knowledge base, quality improvement occurs quickly – as many Web 2.0 projects demonstrate.

On a system-development level, the following supporting objectives can be added:

Supply Application Components for Semi-automated Referencing. User interaction is crucial for building a knowledge base that comprises domain expert knowledge. Still, manual user intervention should be as minimal as possible in order to achieve system acceptance. Thus the system should be able to perform standard operations in an automated mode.

Allow Integration into Arbitrary Applications. In order to allow access to the knowledge base from arbitrary process contexts, any process-supporting application should, ideally, be able to communicate with it. One possible way of achieving this goal could be to provide access to the knowledge base via a standardized interface, e.g., as a web service over the Internet.

Security and Privacy Issues. Adequate security engineering represents an important aspect of the conception and technical realization of semantic referencing, as data security, data consistency and confidentiality are of critical importance in the area of the e-business data interchange (Rebstock and Tafreschi 2002). This aspect includes access control issues as well as the trustworthiness of the information supplied by the knowledge base and the reliability of the underlying IT infrastructure.

1.4 Business Application Domains

In this book, not only do we discuss research results and develop novel methods and a methodological framework for ontologies-based business integration, but we also report on the development of application components based on web services that support the dynamic semi-automated referencing of information structures. The self-learning synchronization components introduced use methods of ontological engineering and artificial intelligence.

Thus, this book demonstrates what ontology management can do for e-business or, more precisely, for process, information and application integration under dynamic e-business conditions. Until now, ontology management and the Semantic Web have been intensively researched but rarely applied to business practice. In spite of the many research activities on semantics, not many projects address the question of how to deal with the parallel use of dynamically evolving semantic systems.

After the consolidation and more quiet growth of e-business activities in recent years, the advances of electronic business integration have entered a new stage and now proceed with changed speed. Application components and web services for ontologies-based business integration can foster this development by supporting a wide range of application domains including:

- Cross-company electronic collaborations
- International trade processes
- Enterprise-wide e-business integration
- Electronic marketplace transactions
- Electronic negotiation applications
- Enterprise application integration
- EDI integration

Following the design strategy developed above, such application components permit referencing standards without prior running of cost-intensive ramp-up projects or strenuous migration projects. Automated services can offer a substantial improvement and efficiency increase in building references between diverse ontologies since the complexity of their semantic structures can, to a large extent, be hidden from the user. As a result, the entry barrier for participating in electronic collaborations is lowered. SME in particular can thus intensify their activities in electronic collaborations and on electronic markets.

1.5 Book Structure

The remainder of this book is organized as follows: In Part I, we introduce the major concepts underlying e-business integration. Business processes, fields of application, and methods and standards for integration within different business and application domains are discussed. In addition, a case study sheds light on the process of creating and maintaining such standards, thus providing valuable insights as to how standards evolve.

Part II discusses knowledge management and semantic technologies, which are used throughout the remainder of the book to analyze and build the methodology and components for dynamic semantic synchronization. Ontologies, methods and tools for both ontology engineering and collective knowledge management are introduced, along with advanced methods and techniques for semantic synchronization. These include concepts from artificial intelligence as well as Web-2.0-like communities and context sensitivity.

In Part III, we develop the concepts and frameworks for e-business integration using semantic technologies. First, we show the functional requirements and application scenarios for the semantic integration of business processes and applications. Second, we show the importance of security management to these kinds of scenarios and develop an appropriate access control framework. As a case study of a practical application for dynamic semantic e-business integration, we describe the ORBI Ontology Mediator. In addition to its function and process design, application architecture and user interaction, we also discuss some key challenges in its application.

In conclusion, we discuss the future of business integration, including development trends and arising challenges.

Part I

E-Business Integration: Processes, Applications, Standards

2 Integrating Processes, Applications and Information

By using electronic transactions to automate business processes, companies seek to optimize processes, accelerate the development of new products and services or access new markets or target groups. The facilitation of seamless electronic information processing is expected to add substantial economic value by generating cost-reduction potential and increasing the speed of process execution while at the same time enhancing the quality of processes, products and services. With seamless electronic communication inside an organization and across its boundaries, with partners, suppliers, and customers, business processes can be automated to an even greater extent, thus increasing their efficiency further.

2.1 The Business Case for E-Integration

Still, assessing the economic impact of information technology (IT) usage is not trivial. The reason for this is that IT generally does not add value directly. It is *business process performance*, defined by business strategies and enabled by IT, that creates economic value (Wigand et al. 1997, 159). Figure 2.1 shows these interrelations.

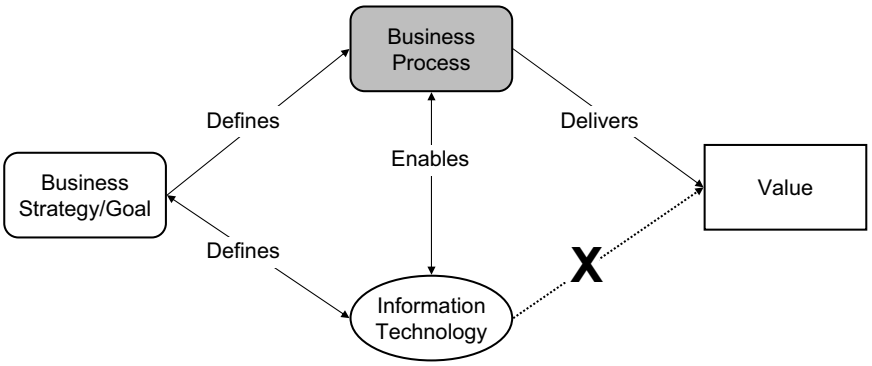

Fig. 2.1. IT and value added (adapted from Wigand et al. 1997, 159)

Thus, before discussing IT solutions, business processes have to be reviewed.

2.1.1 The Business Process Paradigm

The emergence of the business process view as a business paradigm has changed the perception and structure of companies and value chains. According to Hammer and Champy (1993, 35), a *business process* is "a collection of activities that takes one or more kinds of input and creates an output that is of value to the customer" A customer can be a market customer or an internal customer, for instance another department within the same company. A business process often crosses the boundaries of several organizational units or organizations. The objective of business process optimization is the creation of an optimal design for the process as a whole, not necessarily the optimization of every single task for itself. Task complexity may even rise in favor of more simple process structures (Hammer and Champy 1993).

The evolution of the business process view first moved from the optimization of single functional processes to the design of cross-functional processes, then, later, whole business domain processes and finally enterprise-wide processes. Major further steps included cross-enterprise approaches, especially SCM (e.g., Chopra and Meindl 2001) and electronic markets (e.g., Rebstock 2000; Bichler 2001; Ströbel 2003). With those approaches, business process analysis and design crossed enterprise boundaries. Major improvements in process lead time, quality and cost may be realized by implementing such processes (Hammer 2001).

A first step in integrating intercompany business processes can be for two companies to couple a single process bilaterally. The highest integration potential is realized by full supply chain network integration, i.e., by coupling all necessary processes of all network partners involved (Nieuwenhuis et al. 2007). Integration needs grow with the evolution stages between these two poles. With full process integration, information flows refer to a multitude of material, financial, and coordination (i.e., planning and business information reporting) processes.

2.1.2 Process Integration

For *routine processes*, information travels with the process flow upstream or downstream mostly along predefined routes. Information for those processes is stored in applications such as ERP, customer relationship management (CRM) or logistics execution systems (LES). Those applica-

tions are generally used by one or more processes. Process integration thus means information integration and, technically, application integration. The essential link between the tasks of a business process – company-wide or cross-enterprise – is information. Establishing non-disruptive information flows is thus the key challenge for successful business process engineering. Figure 2.2 shows a sample process chain with its respective applications and information flows.

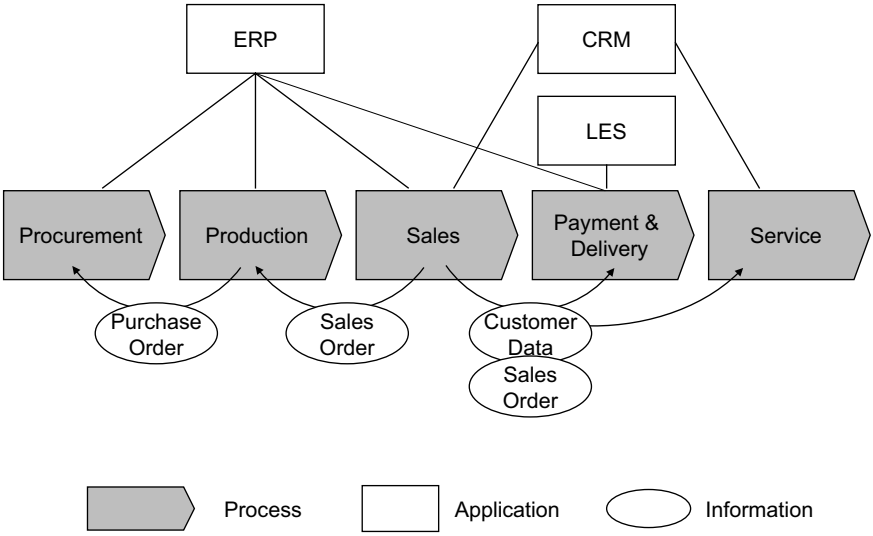

Fig. 2.2. Integration of processes, applications and information

For *ad-hoc processes*, in which structure and flow are not predefined, the applications used and information exchanged vary depending on the specific business case. Those kinds of processes form an even greater challenge for integration, as the methods and applications supporting these processes have to be much more flexible if they are to be interconnected in different business contexts. Most business process integration projects today still deal with routine processes, but there is a growing demand for the support of ad-hoc processes.

2.1.3 Business Processes and Information Technology

Information technology plays an important role within the business process paradigm. It is an *essential enabler* for organizational and management concepts (Hammer and Champy 1993). Without IT support, most process

optimization concepts and projects would not be possible. In addition to being an enabler, IT also serves as an *accelerator* by allowing processes and information to travel more quickly through an organization than was previously possible. It is not surprising, then, that IT still is often referred to as a *key success factor* for business process optimization.

Because of this, IT is also a *challenge* for an organization. From a business perspective, every technological change or innovation poses the question of how it can contribute to further improving organizational performance. The business challenge is to deploy the new technology at the right time – not before it can contribute to value creation, yet before competitors can reap the benefits. It has to be noted that large companies often have better potential for establishing cross-company business processes in terms of financial resources, market power and technological and business know-how. Small and medium-sized enterprises are in many cases only part of supply chain or e-market networks if a large partner initiates their participation. The reason for this is that today's process integration requires significant financial resources as well as business and technological know-how to be established successfully. The underlying information and application integration is not as straightforward as many wish it would be. Therefore, a major step forward, especially for SME, would be the development of methods of integration that are easier to deploy and use than those available today.

2.2 Application Integration

Over the past 20 years, with the emergence of the Internet, application structures as well as the infrastructure for application integration have changed dramatically.

2.2.1 Networks for Application Integration

On a technical level, the exchange of information between applications is based on an electronic network infrastructure. Within companies, networks have been created and expanded over time. In the time of mainframes, data exchange was often triggered by departments processing mass data, such as production or accounting. With the dissemination of the personal computer (PC) throughout all company areas, computer nets for different purposes emerged and department nets were linked together, forming local area networks (LAN). With international expansion, company mergers or acquisitions, these nets were expanded to organization-wide nets – wide

area networks (WAN) – that linked computers over a geographically scattered region. Before the ubiquitous availability of the Internet, proprietary data nets were set up to connect external business partners, usually by large international providers. Access to these nets was limited to subscribing companies. Hub services of value-added networks (VAN) were used for intercompany data exchange in electronic collaborations. With the growth of the Internet, VANs have lost their dominance in intercompany communication. Naturally, the use of the open Internet posed new challenges with regard to the protection of business data. When implementing integration solutions, the technical requirements for intracompany enterprise application integration (EAI) are very similar to those of intercompany scenarios, i.e., business-to-business (B2B) integration.

2.2.2 Business Applications

The use of the Internet has led to substantial business transformation and to the creation of what is now called "electronic business". Electronic business (*e-business*) denotes the support of communication and business processes through electronic communication services in potentially all functional business areas (Rebstock 2000). This involves data interchange in possibly all areas within an enterprise as well as across company boundaries. E-business encompasses electronic commerce (*e-commerce*), focusing on sales and distribution, as well as electronic procurement (*e-procurement*), focusing on sourcing. Furthermore, e-business also includes electronic communication services used in other enterprise departments such as human resources or finance and controlling.

Business application systems can be conceived of as tools for e-business activities. With respect to focus, we can distinguish roughly between *intraorganizational* and *interorganizational* business application systems. Intraorganizational applications include *lateral*, *operational* and *management applications*.

Lateral applications are used in potentially any workplace of the company for basic information processing and communication tasks, i.e., for word processing, calculation, presentation and personal electronic communication such as e-mail. Workflow management systems (WfMS) allow process flow automation, an even higher degree of integration than information flow integration.

Internal operational applications span a wide range of function-specific and industry-specific application components. Function-specific components support functions such as finance, accounting, human resources, sales or procurement. Industry-specific components support processes in

specific industries, such as production planning and scheduling (PPS) applications, manufacturing execution systems (MES) or LES for discrete or process manufacturing, warehouse management (WM) for retail or wholesale companies or other specific solutions for the banking and insurance industry. Today, most of these application components are sold packaged as complete software solutions, especially as ERP systems, but also – often focused on only slightly different business aspects – as CRM or similar applications.

Management applications include planning, reporting and analysis tools such as data warehouses (DW) or business intelligence (BI) applications.

Interorganizational applications support intercompany information exchange. This information exchange takes place mainly through EDI, SCM and electronic market applications. Those are discussed in more detail below.

2.2.3 Intercompany Document Exchange – EDI

Electronic intercompany document exchange includes non-formatted personal communication such as e-mail – already mentioned above – as well as formatted data as part of business transactions. For formatted, or structured, business data, document exchange today normally is performed via EDI. Electronic data interchange denotes the automated exchange of structured e-business documents between applications (Rebstock 2000). The document types exchanged span a wide range of mostly operational business documents including procurement, sales, logistics and finance documents, e.g., requests, offers, orders, delivery notes, invoices, shipping documents or payment orders. As in traditional, non-electronic business relations, the document flows within market transactions follow comparatively stable patterns. EDI usually works asynchronously, as messages are sent to a partner to be processed according to their schedule, without direct real-time interaction of the application systems on both sides. Normally the data exchanged has to be converted to an in-house format after transmission to be usable in internal application systems.

Using EDI, an enterprise may communicate with many partners, such as suppliers, customers, banks, authorities or logistics partners. In doing so, the company may be part of a supply chain network with or without a dominating partner. According to Porter (1985), a company's process chain activities include primary and secondary, or support, activities. Both can operationally be supported using EDI, thus allowing the vision of an overall EDI-based process chain, as illustrated in Figure 2.3.