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An Analysis of the B2B E-Contracting Domain - Paradigms and Required Technology

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Abstract:
Business-to-business e-contracting gained attention in recent years as a way to improve traditional paper contracting. However, a complete framework specifying the aspects of improvement of traditional paper contracting and the new opportunities introduced by e-contracting is still missing. In this paper, we identify the improvements and the new opportunities introduced by e-contracting. The information technology required for the implementation of an e-contracting system is investigated. The paper allows companies to clearly identify the improvements pursued by them when employing e-contracting and the requirements (business and technological) that have to be satisfied for the achieving of the aimed improvements.

Keywords and phrases:
e-business; e-contracting; e-contracting paradigms; e-contracting technology.

1 Introduction

Contracts in business-to-business relations are used to increase the level of trust between parties by providing a description of the values that have to be exchanged and the procedure for their exchange. Over the years, the business world has become more dynamic and demanding to the business parties. The new business conditions faced companies with an increasing contracting overload. The number of contracts established by one company has grown significantly [21]. Contract content has become more complex, providing a more clear description of the promised service or product delivery and a better protection to companies [17]. The high number of established (potentially complex) contracts has lead to contract management problems for companies due to the high costs and high time requirements. Naturally, bad contract management can lead to contract violations and missed opportunities and thus to significant financial losses for companies. The globalization in trading relations demands the establishment of trading relations between partners from different world regions in pursue of the best trading opportunities. However, many companies cannot afford the high contracting costs involved in distant trading which decreases their market competitiveness. In the highly dynamic business world nowadays, companies have to switch between different partners, profiting from the best

1 This paper improves and extends the result first published in [27].
trading opportunities at the moment. This requires companies to be able to establish short-term contracts quickly and cheaply. New business paradigms that aim to improve the competitiveness of companies like dynamic virtual enterprises and dynamic service outsourcing appear and require an adequate contracting support \[26\], \[33\], \[57\]. However, with traditional paper contracting the new trading conditions and opportunities cannot be adequately addressed by companies.

The involvement of information technology in the contracting process is the obvious approach to deal with the outlined problems in traditional paper contracting, E-contracting (electronic contracting) aims at the automation of contract establishment and enactment. E-contracting can be applied to solve cost, time, complexity, etc. problems that occur in paper contracting. Furthermore, e-contracting can be used to support new business paradigms, providing in this way, new opportunities to the contracting parties.

This paper provides an elaborate, complete and structured description of the basic application dimensions of e-contracting. First, we investigate the different aspects of paper contracting that can be improved. Next, we present the concept of e-contracting. We show that the e-contracting concept is currently used to denote two different types of e-contracting. We name these two types of e-contracting shallow and deep e-contracting and briefly discuss them. In this paper, we investigate the domain of deep e-contracting, which in contrast to shallow e-contracting, introduces significant changes to the businesses processes of a company, and sets business, legal, and technological challenges for its implementation. Using the initially identified aspects of improvement of paper contracting, we outline and discuss the fundamental application dimensions of deep e-contracting, i.e., the paradigms of deep e-contracting. We explain when these paradigms can be applied and how they can be combined. Next, we briefly describe the previously defined 4W framework for e-contracting \[6\] that specifies the concepts from the e-contracting domain and the relations between them in a clear and well-structured manner. The 4W framework provides a good foundation to relate the identified e-contracting paradigms to the various e-contracting concepts. With this step, we aim to observe the specific requirements that each of the paradigms has on the involved concepts in an e-contracting process. This allows us to conclude which concepts require special attention for the implementation of one of the e-contracting paradigms. Identification of requirements of the e-contracting paradigms on the e-contracting concepts is essential for the implementation of these paradigms.

An e-contracting system can be viewed as a complex system that combines several types of information technologies used during the contracting process. A preliminary general knowledge about e-contracting systems has already been accumulated as a result of the research projects in the domain (e.g., \[11\], \[15\], \[49\]). Based on this knowledge and previous work that we have conducted \[5\], we define a general e-contracting architecture, and we describe the information technologies that are required for its support. We use the identified requirements of the paradigms on the e-contracting concepts to discuss the specific requirements on the information technologies in the employment of each of the paradigms.

We envision that companies, depending on the context of their business, will implement only some of the e-contracting paradigms in their contracting relations. Implementation of certain paradigms will be impossible or needless for some businesses domains. As a result, the supporting e-contracting systems will vary among companies in accordance with the e-contracting paradigms aimed by this company. In this paper, we show how the choice for support of the different e-contracting paradigms affects the corresponding e-contracting information system.
This paper is structured as follows. In Section 2, we describe the dimensions of traditional contracting that can be improved by e-contracting. Section 3 provides a discussion on deep and shallow e-contracting. In Section 4, we discuss the basic paradigms for deep e-contracting and their possible combinations. Two business scenarios are used to illustrate the application of the paradigms and their combinations. Section 5 introduces briefly the previously defined 4W e-contracting framework and relates each of its concepts to the deep e-contracting paradigms. In Section 6, we describe a general conceptual architecture for e-contracting, the information technologies that are required for the support of this architecture, and the specific requirements of the different paradigms on these technologies. Finally, in Section 7, we briefly describe two advanced research projects on e-contracting and the broadest in its goals and support standardization effort in the domain of electronic business. For each of them, we examine their support for the different e-contracting paradigms. The paper ends with conclusions.

### 2 Contracting dimensions improved by e-contracting

The benefits from the introduction of information technology in an enterprise have been widely discussed in the literature. However, the existing approaches for classification and measurement of the benefits from the introduction of information technology in a company have no solid theoretical foundation \([31]\). Two types of approaches exist in the literature. In the first type, the benefits are assessed only in terms of financial values, whilst in the second type, other aspects in addition to the financial benefits are taken into account. Parker and Benson provide in *Information Economics* \([56]\) a broad discussion on the need for other aspects in addition to the financial benefits to be examined. The authors describe a framework of the values that can be provided by the introduction of information technologies in the enterprises. This publication gained attention and later on it was elaborated and extended in *Strategic transformation and information technology* \([57]\). In our work, we use the classification of values of information technology that is introduced in \([57]\) as a foundation for the identification of the values delivered by the use of information technologies in the process of contracting.

In *Strategic transformation and information technology*, five generic categories of values and risks are identified, i.e., financial values, strategic values, stakeholder values, competitive strategy risk, and organizational risk. Each of these categories has subcategories. For example, strategic values can be *strategic match*, *competitive advantage*, *competitive response*, *management information*, and *strategic IT architecture*. Stakeholder values can be *service and quality*, *environment quality*, *agility*, *cycle-time*, and *mass customization*. Clearly, some of the enumerated subcategories are not applicable for the domain of contracting. *Environment quality* measurements make sense only for information technologies in the context of products, services, or processes that can lead to environment pollution. Thus, this subcategory is not relevant for the contracting process. *Competitive response* measures the possible losses for an enterprise if this technology is not addressed. This subcategory has to be measured in the specific enterprise context and for this reason we do not discuss it. We group the competitive strategy risk and organizational risk categories and their subcategories in one category *Risks*, as discussion of risk values of e-contracting is not part of our goals in the paper. This strategy of tailoring the taxonomy for identifying the values of information technologies in specific situations is
advocated by Parker as well. Finally, we limit the values and risks introduced by information technologies to the following categories and subcategories:

- Financial values
- Strategic values
  - strategic match
  - competitive advantage
  - management information
  - strategic IT architecture
- Risks
- Stakeholder values
  - quality
  - cycle-time
  - agility
  - mass customization

In this chapter, we aim at the identification of values and risks introduced by e-contracting. However, we do not provide a detailed description of the values and risks, nor a measurement and assessment strategy. These are often company and context specific and must be addresses individually when evaluating the need to employ e-contracting. The methodology provided in [56] and [57] can be used as a starting point for such an evaluation.

Next, we briefly describe each of the identified categories and their interpretation in the context of e-contracting.

2.1 Financial values

Traditional paper contract establishment and management require participation of people. This raises the costs of the process significantly. However, to stay competitive, companies have to be able to support large number of contract relations when their production resources allow this [21]. Decreasing the costs for contracting and management is an imperative issue for the dynamic world of the business relations. Use of information technology for automation of the contracting process can decrease the costs in traditional contracting by eliminating the human involvement (labour costs, travelling costs, human driven mistakes, etc.), by improving the business processes, by avoiding the use of physical materials (paper, ink), etc. Electronic contracting can decrease costs in other business departments of the enterprise as well. For example, service delivery can benefit from e-contracting by reacting immediately to contract breaches, preventing losses from service deliveries to inaccurate business partners. In addition to the financial economies for a company, e-contracting can introduce due to the decreased costs new possibilities to the parties as well. For example, cheap contracting allows contracts to be established in situations where previously this was not economically well-founded. A discussion on the methodology for calculations of the financial values introduced by information technologies is provided in [56].

2.2 Strategic values

Strategic values contribute to the accomplishment of the external strategy of a company. They allow improvement of market positions, customer relationships, etc. The following strategic values improved by information technology are of importance in the context of the contracting process:
Strategic match
This value measures the degree to which the information technology matches with the company strategic goals. Contracting is an important secondary business process that supports the execution of primary business processes. That is why it can only complement the strategic goals of a company by supporting the contracting strategies of the company. The basic goal pursued by an e-contracting application is to fully (or partially) substitute the humans involved in the process of traditional paper contracting, i.e., it substitutes machine power for human power. Thus, in its nature, e-contracting is a substitutive application. E-contracting can have also complementary functions, e.g., providing a better contract quality. As a substitutive and complementary application, an e-contracting application is able to support the contracting strategy of the enterprise. E-contracting introduces a number of new opportunities that can be used to support new, providing a competitive advantage to the enterprise strategies. Support for innovative trading strategies of an enterprise is another e-contracting value. Thus, an e-contracting application is a substitutive, complementary, and innovative application supporting current and innovative enterprise strategies.

Competitive advantage
Parker identifies three basic objectives that must be achieved by the introduction of information technologies in order a company to gain competitive advantage [57], i.e., change of the structure of competition, improvement of the position in the existing business, and creation of new business opportunities. E-contracting can lead to changes in the structure of competition by increasing the dynamics of the trading relations (shorter duration of the relations between companies, easier switching to new parties, etc). A number of new opportunities are introduced through e-contracting (e.g., contracting at the latest possible moment, contracting of small quantities of products or cheap services). We discuss the new opportunities introduced to companies in more details in Section 4. The new opportunities can lead to improvements in the market positions of a company. For example, companies will be able to react better to the best contracting opportunities in the market. Thus, e-contracting satisfies the three basic objectives and adds value to the competitiveness of a company.

Management information
Better management and use of information is another strategic value introduced by e-contracting. According to Goldman Sachs, contract management efficiency can be improved up to 50 percent [21]. The management of the contractual relations of a company includes observance of the current, past and future contracting relations, i.e., their starting and ending time, possible renewals, existing dependencies, risk management, etc. Digital representation of contracts allows the management of the contracting relations of a company to be automated. The reduced contract management time and the improvement of management quality lead to reduction of missed opportunities. Furthermore, proper management of the contracting relations can be beneficial for the management of the overall strategies of a company. This value introduced by information technologies is of high importance in the context of the modern contract-intensive businesses.
Strategic IT architecture
In this subcategory, the alignment of the suggested information technology with the rest of the information technologies in an enterprise is evaluated. E-contracting allows an important linkage between the contracting system and the production (or service delivery) control system and between the contracting system and the management system to be established. Automatically interpretation of the contract content allows the involvement of people currently required to link the contracting systems with the delivery and management systems to be avoided. Thus, a control system (e.g., a Workflow Management System) or a contract management system can automatically make use of concluded contracts and organize their execution and respectively management. Clearly, e-contracting can add significant value to the integrity of the information technology in a company.

2.3 Stakeholder values
Stakeholder values relate to the values that are introduced to the possible stakeholders (e.g., suppliers, customers) by the implementation of information technology in the contracting process.

Quality
Improving the quality of the contract content and process is an issue that can be addressed by e-contracting. All stakeholders can benefit from the improved contract quality, guaranteeing better trading relations and protection. The contract content quality can be improved by checking for consistency of the contract terms, and by providing support for the creation of contract clauses. This can be of help especially in the cases of complex contracts, containing large number of contract clauses and product/service details.

Cycle-time
The cycle-time subcategory is related to the decrease of the time for the performance of the complete or part of the cycle of product/service innovation, production and delivery that can be achieved by the use of information technologies. Contracting is an essential part of this cycle. It is related to the realization of the company’s products or services on the market. Goldman Sachs estimates the average time to create and negotiate a contract to be 15 weeks [21]. Clearly, such a period of time increases the life-cycle significantly and can be too long in business situations that require fast contract establishment. Automation provided by e-contracting allows the time required for contract establishment to be decreased. Fast contract establishment is a requirement for dynamic business relations, especially when contracts have to be established in a split second. E-contracting can significantly speed up the process of contracting, leading to reduced cycle-time in the company.

Agility
In traditional paper contracting, the lack of agility in the contracting process can hinder companies from entering into trading relations or can cause substantial inconveniences to companies. For example, due to the substantial time and synchronization (of people and processes) requirements, companies can often not contract at the best moment with the most advantageous party. This often forces companies to establish long term contractual
relationships. E-contracting can reduce the time requirements for contracting (addressed in the preceding paragraph) and the requirements on synchronization of people and processes. These improvements introduced by information technologies lead to improved agility of companies in the contracting process.

**Mass customization**

Nowadays, markets require mass customization of products and services. “The new definition of success becomes the ability to accelerate production of an ever greater variety of customized products” [57]. In the context of contracts, the demand for mass customization is expressed in the establishment of highly specialized contracts, tailored to support specific, limited in time and costs value exchanges. E-contracting can answer to this market demand by providing automatic contract customization for the exchange of limited amounts of specific products or services. Thus, e-contracting can add value to the mass customization potential of traditional paper contracting supported by companies.

### 2.4 Risks

The introduction of e-contracting as a new technology in a company creates new risks. These risks can have external focus, i.e., competitive strategy risks (e.g., political, business, legal, standardization), or an internal focus, i.e., organizational strategy risks (e.g., business restructuring risks, security risks). In this paper, we do not further discuss the risks that arise from the introduction of e-contracting in companies. This requires attention in the specific business cases. It must be noted that in addition to the risks introduced by e-contracting, this new technology can allow currently existing risks to be decreased as well. E-contracting can reduce the existing risks between contracting parties by improving the contract quality, reducing costs and time, improving parties’ flexibility, or through the new opportunities which it provides. For example, the existence of reputation centres [50] that automatically supply information about a possible contracting party is an opportunity introduced by e-contracting which reduces the risk of entering in contracting relations with companies with bad contractual reputation. Automatic evaluation of the enacted contracts gives the necessary feedback to the reputation centres.

In this section, we have shown that e-contracting can introduce a wide variety of benefits to companies that employ it. In the next section, we take a closer look at the two basic types of e-contracting that companies can employ.

### 3 Deep and shallow e-contracting

Many definitions of contracting and e-contracting have been given until now, e.g., [59], [42], [52], [17]. Definitions of e-contracting are based on the use of information technologies for the contract representation and for the support of the contracting process. However, in the various approaches to e-contracting, no attention is paid to the different levels of automation than can be achieved by the use of information technologies in the contracting process. In this section, we show that the level of automation leads to two different types of e-contracting, i.e., shallow and
deep e-contracting. Next, we give definitions of the two types of e-contracting and illustrate them with short examples.

**Definition 1**

*Shallow e-contracting* is contracting in which:

1. information technologies are used to support the contracting process;
2. contracts have digital representation;
3. the level of automation introduced by the use of information technologies does not lead to new business processes in a company (or to significant changes of the existing ones).

**Definition 2**

*Deep e-contracting* is contracting, in which:

1. information technologies are used to support the contracting process;
2. contracts have digital representation;
3. the level of automation introduced by the use of information technologies leads to new business processes in a company (or to significant changes in the existing ones).

As it can be noticed, **Definition 1** and **Definition 2** differ only in their third point concerning the level of automation of the contracting process. Naturally, the level of automation of e-contracting is a continuous function and the exact boundary between shallow and deep e-contracting can be hardly determined (see Figure 1). In Section 4, we describe the paradigms of deep e-contracting. This allows a better understanding of the deep e-contracting domain and its distinguishable features as compared to the shallow e-contracting to be achieved. Shallow e-contracting can lead to minor improvement of the financial and cycle-time values (mostly due to cheap and fast communication and storage technologies). Deep e-contracting focuses on the entire spectrum of dimensions of improvement, involving the usage of a broad spectrum of information technologies.

**Example 1 – shallow e-contracting**

An example of shallow contracting is the use of a text editor for creation of a contract (this might involve the use of previously created contracts or contract templates) and the exchange of the contract through e-mail. This example shows that e-contracting can be introduced as an improvement of traditional contracting in respect of time and costs. However, this scenario requires considerable involvement of people and as a consequence no significant changes in the business process of the company will take place. The prototype implementation described in [29] is an example for a system supporting shallow e-contracting (positioned in the domain of shallow e-contracting in Figure 1). Another example for a system supporting shallow e-contracting is the system presented in [45].

**Example 2 – deep e-contracting**

The following scenario is an example for deep e-contracting. A company has a dedicated e-contracting system. The system can retrieve a list of possible contracting parties automatically. Based on the set criteria, the e-contracting system can negotiate and establish an e-contract with
one of the retrieved parties. The high level of automation of the contract establishment process allows the establishment of contracts in a very short period of time. Fast e-contracting provides the opportunity for the company to react in time in highly dynamic markets and thus to achieve better trading conditions. This new opportunity requires from the company new business models and strategies. The business model of the company should be changed to support fulfilment of contract obligations without prior preparations, as contracts can be established in a very short time interval. The example shows how higher levels of automation of the contracting process, can lead to changes in the internal business processes of a company. The prototype system described in the CrossFlow project [15] is an example for a system supporting deep e-contracting.

![Figure 1 – The level of automation of the contracting process](image)

As stated in the definition, shallow e-contracting does not introduce changes to the business processes of a company. Consequently, shallow e-contracting does not lead to new opportunities for the trading parties. Its implementation cannot give a significant competitive advantage over the other companies. Furthermore, for the support of shallow e-contracting, existing software applications can be used or adapted (e.g., e-mail, text editors, secured web forms). Deep e-contracting leads to the restructuring of the existing business processes or to the introduction of completely new processes. As advocated by Parker, “Change is the basis for value in information technology” [56]. This allows companies to improve their efficiency and effectiveness significantly, as well as to benefit from the new opportunities that occur. Furthermore, deep e-contracting poses substantial research problems with respect to the new business processes, new business opportunities, and supporting technology. Thus, deep e-contracting is of interest from both business and research perspective. For this reason, in this paper, we concentrate on deep e-contracting. Through the rest of the paper, the term e-contracting is used as an equivalence of the term deep e-contracting. In the next section, we provide a description of the most characteristic aspects of the domain of deep e-contracting.

### 4 Description of deep e-contracting

In this section, based on the aspects of improvement of paper contracting introduced in Section 2, we identify the paradigms of deep e-contracting. We discuss the combinations of paradigms (hybrid paradigms). At the end of the section, we provide two business scenarios as an illustration of the different paradigms and their combinations.
4.1 E-contracting paradigms

In Definition 2, we have stated that deep e-contracting leads to new business processes or to significant changes in the existing processes, due to the high level of automation introduced by the use of information technologies. New business processes (or changes in the existing ones) are directly related to new opportunities to the contracting parties. Next, we identify the basic new opportunities that are introduced by deep e-contracting.

**Definition 3**

An *e-contracting paradigm* is a basic concept in deep e-contracting that describes a new opportunity for a contracting party introduced by the use of information technologies in the process of contracting.

Definition 3 requires that each paradigm describes a single new opportunity for companies. With this, we aim at clearly distinction of the new opportunities introduced by e-contracting, avoiding the merge of two different paradigms into one complex paradigm. In fact, Definition 3 contains four requirements for the definition of a paradigm. First, the definition relates to the domain of deep e-contracting (see Definition 2), i.e., the requirements for use of information technology, for digital representation of the contract, and for changes in the existing business processes in a company. Second, a paradigm must introduce new opportunities to the parties. Thus, to identify the e-contracting paradigms, we have to identify the new opportunities for a company that lead to new business process or to significant changes in the existing ones (assuming that information technologies and digital contract representation are used).

We have identified the values introduced by use of information technologies in contracting (see Section 2). These values can be taken as a starting point for the identification of new opportunities for companies. For each identified new opportunity, we have to show that it leads to new business processes or to significant changes in the existing ones.

In Section 2 we have outlined nine dimensions of improvement of traditional contracting (not considering the risk dimension that cannot be a source of new opportunities). The strategic match dimension can be left out from consideration, as this dimension is related to measuring the value of information technologies at a high strategic level, and cannot be used for the identification of new opportunities. As we have discussed, a competitive advantage gained due to e-contracting creates new business opportunities for the company, alters the industry structure, and improves the position of the company in the existing business (see Section 2.2). Thus, studying of the competitive advantages introduced by e-contracting is a task that contains our current goal, i.e., to identify new opportunities for companies. That is why this dimension of improvement can be left out of consideration as well. The financial and cycle-time benefits are basic ones and are always introduced by information technologies in e-contracting (see discussion in Section 3).

These dimensions are valid for shallow contracting as well. Consequently, they cannot independently introduce a new paradigm in e-contracting (however, as we show later on, these dimensions are the basis for the existence of some of the e-contracting paradigms). In this way, five dimensions remain for consideration as a starting point for the identification of new opportunities for companies i.e., the management information, strategic IT architecture, quality, agility, and mass customization dimensions. In this section, we show that each of these dimensions of improvements introduces a new e-contracting paradigm.
New opportunities in the contracting domain for companies can be related to one (or more) of the three business processes that contracting comprises, i.e., contract establishment, contract enactment and contract management (see Figure 2). The contract establishment process is the process of finding suitable contracting parties and negotiating a contract with one of them. Contract enactment is the fulfillment of the promised obligations of the company while obtaining the corresponding benefits. Contract management is the process of management of the contracting relations of a company. The contract management process starts before the contract establishment process, runs in parallel to the contract establishment and enactment and ends after the completion of the contract enactment process.

![Figure 2 – E-contracting related business processes](image)

At the end of this section, we describe the relations between the identified paradigms and the e-contracting business processes.

### 4.1.1 μ (micro)-contracting

Decreasing the costs for contracting (see Section 2.1) allows contracts to be customized on a large scale. We call this new opportunity the μ-contracting (micro-contracting) paradigm. In the micro-contracting paradigm, contracts can be customized to reflect customer’s (or supplier’s) preferences on a product, service, or the various conditions for their delivery. This mass customization leads to the establishment of many small contractual business relationships to support a high level of selectivity and specialization in business collaboration. Micro-contracting requires from companies to adapt their business processes to support the existence of many different contracts, possibly with different contracting conditions. For example, new logistic solutions can be required for the delivery of single or small products quantities per contract. Micro-contracting requires an adequate management support, which allows the high number of cheaply established contracts to be cheaply managed (see Section 4.2).

### 4.1.2 τ (just-in-time)-contracting

E-contracts can be established in extremely short time intervals due to the high level of automation. The possibility for fast and agile offers to companies the opportunity to establish contractual relationships in the most suitable for them moment, with the preferred contracting party and contracting conditions. We call this paradigm τ-contracting (just-in-time-contracting). Just-in-time-contracting allows companies to react in the best way to temporal market dynamics. This paradigm requires from
companies to adapt their business processes for the support of contract enactment in accordance with the fast contract establishment. For example, flexible just-in-time logistic solutions can be required for the support of just-in-time contracting.

4.1.3 \( \pi \) (precision)-contracting

Nowadays, market participants require higher quality of the offered products and services \([57]\). This leads to a more detailed description in the contract content of the product/service and the delivery conditions. It is often the case that the length and complexity of contracts cause problems to companies during the contract establishment. In these situations, the quality of the established complex and long contracts can be considerably improved through the use of e-contracts. E-contracts allow complex contracts to be created and to be verified for consistency against internal (company) and external (business, legal, etc.) requirements. We call this new opportunity the \( \pi \)-contracting paradigm (precision-contracting). Precision-contracting allows companies to improve the quality of their contracting relations, by avoiding clause redundancy, contract clauses omissions, inconsistencies, etc. Precision-contracting eliminates or shortens internal business processes related to the contract quality control. For example, rules applied on several contract clauses can determine automatically the combinations in which the clauses can be used or the possible values of the parameters in these clauses.

4.1.4 \( \varepsilon \) (enactment)-contracting

The contract establishment process is followed by the contract enactment process (see Figure 2). Contract enactment is the performance of the contract and the control over its performance \([5]\). The performance of the contract includes the exchange of values between contracting parties and the execution of any related activities as defined in the contract. Control over the contract performance caters for the proper and precise contract performance. As we have discussed in Section 2.2, strategic IT architecture is a value introduced to companies by e-contracting. E-contracting allows the contracting information technology supporting the contract establishment process to be linked to the contract enactment process. The opportunity for parties to automatically link the contract establishment and the contract enactment due to the use of electronic contracts introduces a new paradigm. We call it the \( \varepsilon \)-contracting (enactment-contracting) paradigm. An essential characteristic of enactment-contracting is the machine interpretability of contracts. This automatic interpretation of the contract content allows the automatic linking of the contract establishment and contract enactment processes. Enactment-contracting allows companies to enact better (faster, more precisely, etc) higher number of contracts. Restriction on the number of enacted contracts is set only by possible limitations on availability of resources for the service/product delivery. Machine interpretability of the contract content by the enactment system allows higher benefits from the contract clauses to be achieved (e.g., prevention of inobservance of contractual obligations, benefiting from all rights of a company defined in the contract). It must be noted that depending on the exchanged value (a product or a service) different levels of automation are possible. In the case of selling of physical products, at
present, the delivery process can usually not be fully automated. However, in the case of services or digital products the process can often be fully automated.

4.1.5 \( \gamma \) (management)-contracting

As we have already discussed, the contract management process is responsible for the management of the contracting relations of the company (see Section 2.2). The opportunity to automatically link the contract establishment process with the contract management process due to the use of electronic contracts, and subsequently to automatically manage it, is another e-contracting paradigm. We call this paradigm the \( \gamma \)-contracting (management-contracting) paradigm. Similarly to enactment-contracting, the electronic representation of the contract is essential for the management-contracting paradigm. The electronic representation allows automatic interpretation of the contract content which leads to the possibility companies to automatically manage their contractual relationships. Consequently, companies can better manage these relationships, e.g., to begin and end contract performances in time, to cater for contract renewals, to track contract dependencies, etc. This paradigm leads to reduced risk for companies, higher profits from contracting relations, improved possibilities for more contracting relations, etc. Consequently, this can lead to process and organization restructurings.

4.1.6 Relations between paradigms and the automated processes

In Figure 3 we have positioned the e-contracting paradigms with respect to the processes they introduce new opportunities to.

![Figure 3 - Relations between paradigms and processes](image)

The micro-contracting and just-in-time-contracting paradigms offer an automation of the complete contract establishment process improving cost and customization aspects and time and agility issues correspondingly. Precision-contracting aims at improving the contract quality. Contract content is negotiated and agreed in the final part of the contract establishment process, and for this reason we have displayed this paradigm as related to only part of the establishment process. The enactment-contracting paradigm
uses the electronic contract to provide automation for the contract enactment. That is why we have denoted it as related to the end of the contract establishment process and the complete contract enactment processes. The management-contracting paradigm is related to the complete contracting management process.

4.2 Combinations of paradigms

In Section 4.1 we have shown that the e-contracting paradigms can be applied to improve specific aspects of the business processes. It is natural that a company will often be interested to employ more than one of the paradigms in order to benefit from more new opportunities. Figure 3 is an illustration that various combinations are possible among the e-contracting paradigms. We expect that certain paradigms will be often used in combination, as their separate usage can lead to undesired complications. In this section, we discuss which combinations of e-contracting paradigms are possible, and which are required in most business scenarios. The goal of this section is to provide a clear description of the possible and required combinations of paradigms, allowing in this way higher benefits from the introduction of deep e-contracting to be achieved.

Combinations of two or more paradigms lead to hybrid paradigms, e.g., just-in-time-micro-contracting – which we call τµ-contracting, or precision-enactment-contracting – which we call πε-contracting. Table 1 lists the e-contracting paradigms identified in Section 4.1 and shows the relation between each of the paradigms. Next, we briefly explain these relations. Not all combinations that are considered as required are reciprocal, e.g., when employing the micro-contracting paradigm it might be important to combine it with the management-contracting paradigm whilst employment of management-contracting does not require a combination with micro-contracting. For this reason, we present the possible combinations in a directed manner, starting with a paradigm from the left column and relating it the rest of the paradigms (i.e., to each of the columns). To avoid redundancy of the explanations, combinations of paradigms that are reciprocal are discussed only once.

<table>
<thead>
<tr>
<th></th>
<th>μ-c</th>
<th>τ-c</th>
<th>π-c</th>
<th>ε-c</th>
<th>γ-c</th>
</tr>
</thead>
<tbody>
<tr>
<td>μ-c</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>τ-c</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>π-c</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>ε-c</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>γ-c</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 1 - Cross-table of the e-contracting paradigms

μ-c ≫ τ-c (and τ-c ≫ μ-c): By combining micro-contracting and just-in-time-contracting, a high level of automation of the e-contract establishment can be achieved, decreasing significantly both the time and costs for the contract establishment and allowing high level of customization possibilities and agility to be achieved. This combination can be used in scenarios in which companies need to establish contracts with multiple companies in a split second.
µ-c >> π-c (and π-c >> µ-c): Micro-contracting can be combined with precision-contracting for the support of cases that require the establishment of multiple contracts with a complex and precise content.

µ-c >> ε-c: A combination between micro- and enactment-contracting allows automation of the establishment and enactment of small trading relations to be achieved. These two paradigms should be combined in most business scenarios, as manual control over the numerous specialized contracting relationships can be often error prone and can be a significant burden for companies. This combination is most powerful when the contract enactment can be fully automated, i.e., in the context of exchange of digital products or services.

µ-c >> γ-c: We consider the combination of micro-contracting and management-contracting (µγ-contracting) as an important one, as automated management is strongly required for the numerous established contracts. Employment of micro-contracting without automated management can lead to full or partial lack of management of the numerous contracts.

τ-c >> π-c (and π-c >> τ-c): Just-in-time-contracting can be combined with precision-contracting. However, this can be achieved only in situations where precision-contracting is fully automated, as just-in-time-contracting provides establishment of contracts in a split second. This is not always the case in the precision-contracting paradigm, as it does not exclude the involvement of a human factor during contract creation.

τ-c >> ε-c (and ε-c >> τ-c): Just-in-time-contracting forms a relevant combination with enactment-contracting. This combination has a strong potential especially in situations where contract enactment lasts a very short time (e.g., a few seconds). In this way, contracts can be established in the last moment and enacted for several seconds, reducing the complete contracting process to seconds, allowing companies to acquire highest profits from temporary market fluctuations.

τ-c >> γ-c (and γ-c >> τ-c): Just-in-time-contracting can be combined with management-contracting as well, achieving proper management of contracts established at the latest moment. Thus, a hybrid τεγ-contracting paradigm provides a strong contracting potential to companies contracting in a dynamic market conditions with short-term value exchange.

π-c >> ε-c (and ε-c >> π-c): Precision-contracting can be combined with enactment-contracting, allowing high quality contracts to be precisely enacted. Automated enactment of complex contracts poses higher requirements on the enactment system, which has to deal with the execution of complex processes and management of complex data flows (see Section 6).

π-c >> γ-c (and γ-c >> π-c): Precision-contracting combined with management-contracting provides automation of the management of complex contracts, which can bring considerable benefits to companies in the management of their complex contractual relationships.

ε-c >> µ-c: Enactment-contracting can be combined with micro-contracting. However, the employment of enactment-contracting independently does not require employment of micro-contracting.

ε-c >> γ-c: The combination of enactment-contracting with management-contracting is required in most scenarios, as automation of the contract enactment without its automated management can bring substantial problems. Problems are due to the human involvement in the management of a highly automated process. This is valid especially in situations where contract enactment lasts extremely short or very long periods of time. Furthermore, in both paradigms the connection with the contract establishment process is an essential aspect. Thus, εγ-contracting allows both paradigms to benefit at the same time from this connection. This combination provides a high automation of the activities following the contract establishment.
Employment of management-contracting can be combined with the employment of the micro-contracting paradigm. In this combination, the automation of the contract management can be easier achieved due to its automated coupling with the enactment system. When this combination is not introduced, the coupling between the contract enactment and the contract management is to be performed manually, by human beings.

4.3 Example scenarios

In this section, we describe two business scenarios that employ e-contracting paradigms. The first scenario presents a combination of the micro-contracting, just-in-time-contracting, enactment-contracting, and management-contracting (µτεγ-contracting) paradigms. The second scenario illustrates combination of the enactment-contracting and management-contracting paradigms (εγ-contracting). In addition, we illustrate how it can be extended with the employment of the precision-, just-in-time-, and micro-contracting paradigms (γεπτμ-contracting). The goal of this section is to give an idea about business scenarios in which companies benefit from the use of some of the paradigms of deep e-contracting.

4.3.1 Logistics example

Our first example is taken from the logistics domain (the scenario is described in detail in [16]). In this scenario, a telecom company sells mobile phones to clients. Clients can remotely order mobile phones from the mobile company. The telecom company, however, is not specialized in logistic support. That is why it outsources the product delivery (i.e., the mobile phones delivery) to a parcel delivery company. The telecom company employs the micro-contracting paradigm and establishes separate contracts for the delivery of each mobile phone. Contracts are based on a contract template and can differ in their content on several parameters, e.g., priority of delivery, value of the delivered phone, delivery address, etc. The establishment of contracts for every delivery of a mobile phone allows the telecom company to change the delivery conditions for every delivery, as well as to change the delivering company itself. In this way, if the telecom company is not satisfied with the current deliverer, it can switch at the next phone order to another deliverer. This reduces the possibility for parties to enter in long-term disadvantageous contracting relations (a “hold-up”), which before has been often the case [43]. Contracts are established only after a mobile phone has been ordered by a client, i.e., the telecom company has a very limited time interval to negotiate and establish a contract. That is why the just-in-time-contracting paradigm has to be employed as well. Thus, the scenario uses the micro-contracting paradigm in combination with the just-in-time-contracting paradigm, allowing contracting the best conditions from the current offers in the market with the preferred at the moment deliverer. As we state in Section 4.2 micro-contracting should be preferably combined with enactment-contracting and management-contracting. To have control over the
numerous payments and its other contractual obligations, the telecom company employs the enactment-contracting paradigm. To manage the high number of established contracts, the telecom company has to employ the management-contracting paradigm as well. This allows the company to initiate in time its contractual obligations, to monitor the performance of the obligations of the parcel delivery company, to perform in time any possible corrections (e.g., change of phone delivery address), etc. Consequently, contracts in this scenario serve two purposes. The main role of contracts in the example is to serve as a protection mechanism for the contracting parties, providing at the same time high flexibility in selecting the business partner. Additionally, as each contract is associated with one specific delivery, better control on the delivery process of every mobile phone (i.e., the execution of every individual contract) is achieved.

4.3.2 Advertisement example

Our second example illustrates the application of the enactment- and management-contracting paradigms in a business scenario. The business scenario that we describe is between a television program production company B-TV and an advertising agency (or an ordinary company) ACME. B-TV offers advertisement spots in their programs. For example, during the broadcasting of a football game, an advertisement can be digitally placed on the field background. When the ACME company wants to advertise through B-TV, it has to provide the digital material (the advertisement) in a specific format, as required by B-TV. B-TV inspects the digital material and if it is approved, the companies can start negotiating on the contract clauses. The contract is often based on a contract template, or on standard contract clauses. When the terms of broadcasting of the advertisement are agreed (time slot, position on screen, pricing, etc), an e-contract between the two companies stating the agreement is concluded. B-TV wants to automate the control on the broadcasting of the advertisement (i.e., the contract enactment). For this reason, it employs the enactment-contracting paradigm. By employing this paradigm, B-TV can automatically retrieve the approved digital material and control its broadcast as agreed in the contract. B-TV establishes many contracts for the broadcasting of advertisements. To better manage its contractual relations and their enactment, B-TV employs the management-contracting paradigm as well (as we have discusses in Section 4.2 the combination of enactment with management paradigm should take place in most scenarios). Thus, B-TV can automatically invoke the execution of the advertisement broadcasting at the required timeslot, the required number of times, check if payment by ACME is performed, notify parties about the status, etc, i.e., to manage and enact automatically the contract. The employment of the two paradigms is feasible due to the fact that in this scenario the electronic contracts are based on standard contracts or clauses, and can be automatically interpreted by the supporting management and enactment systems. Thus, in this case, in addition to the protection aspect, electronic contracts are the specification document used for the automatic contract enactment and management.

The example can be extended to include the precision-contracting paradigm as well. By employing the precision-contracting paradigm, it will be possible contracts to be extended over the standard contracts, combining various standard clauses. Contracts
would be verified automatically and omissions or contradiction of clauses could be avoided. In this example, just-in-time-contracting can take place in a limited form. It will allow the ACME company to wait until the last possible moment for contract conclusion (expecting lower prices for the spot, higher audience percentage, etc). However, just-in-time-contracting will require previously approved advertisements to be used, as the advertisement cannot be broadcasted before being inspected and approved by B-TV. An interesting possibility would be the employment of micro-contracting, allowing the establishment of contracts for the broadcasting of a single time advertisements. This will introduce to ACME the possibility for new marketing strategies created on the base of making single time advertisements (micro-contracting) in the most suitable for them moment (just-in-time-contracting).

5 The e-contracting paradigms and the 4W framework

In Section 4.1 we have identified five e-contracting paradigms. Each of these paradigms has a number of requirements for its employment. These requirements can be on the contracting context, the contract content, the contracting process, etc. For example, in Section 4.3 we have shown that only some of the e-contracting paradigms can be employed in the specific examples, i.e., in the specific context. To further improve the understanding of the e-contracting paradigms, it is important to identify the requirements that each paradigm has for its employment. However, a complete and detailed requirements identification demands a profound and structured knowledge of the e-contracting domain. In our previous work, we have described the 4W conceptual e-contracting framework [2], [3], [6]. The 4W framework presents the concepts from the e-contracting domain and the relations between them in a clear and well-structured manner. Thus, the 4W framework provides a convenient tool for requirements identification for the employment of the e-contracting paradigms.

In this section, we start with a short overview of the 4W framework. Next, we investigate the relations between the e-contracting paradigms and each of the e-contracting concepts from the 4W framework and identify requirements for the employment of the different paradigms. The identified requirements are used in Section 6 to draw basic conclusions on the supporting information technologies for the different e-contracting paradigms.

5.1 The 4W e-contracting framework

The central concept in the 4W e-contracting framework is the contract concept. The contract concept is associated with four basic groups of concepts, i.e., the Who, Where, What, and How groups (see Figure 4).
• The **Who** group of concepts models the *actors* that participate in the contract establishment and enactment. The involved actors can be consumers, suppliers, auxiliary implementors, and mediators.

• The **Where** group of concepts models the *context* of the contract. The context can be business, legal, geographical, etc.

• The **What** group of concepts models the *exchanged values* and their *exchange*. It includes the product, service, money, exchange description concepts.

• The **How** group of concepts relate to the *means* for contract establishment and enactment. It includes the different contracting phases (information, pre-contracting, contracting, and enactment), the contract representation, content, structure, and related standards.

Certain relations between the **Who**, **Where**, **What** and **How** groups of concepts exist, e.g., the involved parties (who) have rights and obligations (what). These relations are explained in greater detail in [2] and [6]. Since they do not contribute to the requirements identification of the e-contracting paradigms, we do not discuss them in this paper.

### 5.2 Relation to the e-contracting paradigms

In this section, we relate the e-contracting paradigms identified in Section 4.1 to the concepts of the 4W framework. The 4W framework contains e-contracting concepts from all possible e-contracting scenarios. Thus, it is likely that some of the concepts would not be involved in some of the paradigms. We distinguish three different situations that can occur. i.e., an e-contracting concept cannot be involved, can be involved, and must be involved in a paradigm. For each group of e-contracting concepts of the 4W framework, we investigate if the concepts in this group can be (or must be) involved in the different paradigms. When a concept can be (or must be) involved in a paradigm, we investigate if there are any specific conditions for it. We call these specific conditions requirements of the paradigm on the specific e-contracting concept. The collection of requirements on all e-contracting concepts for a given paradigm represents the requirements for employment of the paradigm.

To represent the relations between the e-contracting concepts and the e-contracting paradigms, we construct tables, mapping the concepts to the e-contracting paradigms. The following notation is used to represent the different possible relations between a paradigm and a concept:
- shows that this concept CANNOT be involved in the corresponding paradigm
C shows that this concept CAN be involved in the corresponding paradigm
CR shows that this concept CAN be involved in the corresponding paradigm but there are certain REQUIREMENTS (specifics) for its use in the specific paradigm
M shows that this concept MUST be involved in the corresponding paradigm
MR shows that this concept MUST be involved in the corresponding paradigm but there are certain REQUIREMENTS (specifics) for its use in the specific paradigm

Next, for each of the four groups of concepts (Who, Where, What, and HoW), we investigate the relations between the paradigms and the concepts that belong to these groups.

5.2.1 Who

The e-contracting concepts that model the involved actors in the e-contracting process are consumers, suppliers, auxiliary implementors, and mediators (see Figure 5). Part of the work that is promised by the supplier in the contract can be outsourced to auxiliary implementors. Mediators facilitate the contract establishment and enactment.

```
Consumer          Supplier          Auxiliary implementor
                /                 /                     /
               /                 /                     /
              /                 /                     /
            Mediator
```

Figure 5 - Actors in e-contracting

In Table 2 we represent the relations between these concepts and each of the paradigms. Every e-contract requires at least two parties, i.e., a consumer and a supplier. There are no specific requirements on them in the different paradigms, except the basic requirement that they support the e-contracting paradigm itself (i.e., all requirements for the employment of the paradigm are satisfied, and the parties have the information technology to support this paradigm). Auxiliary implementors and mediators can be involved in all e-contracting paradigms. Analogously to the involvement of the contracting parties, the only requirement on auxiliary implementors and mediators is to support the e-contracting paradigm they get involved in.

<table>
<thead>
<tr>
<th>Consumer</th>
<th>Supplier</th>
<th>Auxiliary implementor</th>
<th>Mediator</th>
</tr>
</thead>
<tbody>
<tr>
<td>μ-c</td>
<td>M</td>
<td>M</td>
<td>C</td>
</tr>
<tr>
<td>τ-c</td>
<td>M</td>
<td>M</td>
<td>C</td>
</tr>
<tr>
<td>π-c</td>
<td>M</td>
<td>M</td>
<td>C</td>
</tr>
<tr>
<td>ε-c</td>
<td>M</td>
<td>M</td>
<td>C</td>
</tr>
<tr>
<td>γ-c</td>
<td>M</td>
<td>M</td>
<td>C</td>
</tr>
</tbody>
</table>

Table 2 - Actors in the e-contracting paradigms
5.2.2 Where

In the 4W framework, we investigate three aspects of the e-contracting context, i.e., the business, legal, and geographical contexts of the e-contracting process, as we consider them as most important. The business and geographical contexts exist for every e-contract. Thus, the business and geographical context fields in Table 3 denote that these contexts exist in all e-contracting paradigms. Companies are advised to position every contract in a certain legal context, e.g., law that will govern their contract. However, if no legal context has been specified by the parties, in case of dispute, the relevant jurisdiction body decides which the applicable law should be \[38\].

<table>
<thead>
<tr>
<th></th>
<th>Business</th>
<th>Geographical</th>
<th>Legal</th>
</tr>
</thead>
<tbody>
<tr>
<td>μ-ε</td>
<td>MR</td>
<td>MR</td>
<td>MR</td>
</tr>
<tr>
<td>τ-ε</td>
<td>MR</td>
<td>MR</td>
<td>M</td>
</tr>
<tr>
<td>π-ε</td>
<td>MR</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>ε-ε</td>
<td>MR</td>
<td>M</td>
<td>MR</td>
</tr>
<tr>
<td>γ-ε</td>
<td>M</td>
<td>M</td>
<td>M</td>
</tr>
</tbody>
</table>

Table 3 – Context concepts in the e-contracting paradigms

Micro-contracting, just-in-time-contracting, precision-contracting, and enactment-contracting are applicable for a specific business context. The requirements on the business context of the different paradigms follow from their definitions. Micro-contracting allows a high level of selectivity and specialization in business collaboration. Thus, it can be applied in specific business contexts that require such level of selectivity and specialization. Just-in-time-contracting can be applied in markets characterized with temporal dynamics. Precision-contracting is suitable for business relations that lead to the establishment of complex contracts. Enactment-contracting can be applied only for the exchange of products and services that allow automation of the enactment process. According to the agreed notation we denote these requirements with “R”. Management-contracting can be applied in any business context without any specific requirements.

Though e-contracting allows companies to trade with other companies from all over the world, micro-contracting and just-in-time-contracting still depend on the geographical context of the business relations. For example, micro-contracting of physical products on large distances is often not economically reasonable due to the high costs for delivery (digital products like music, software, etc. set no geographical limitations for micro-contracting). In just-in-time-contracting, contracts are established at the latest possible moment, which leads to the requirement that both parties are available at the moment of contracting. This can limit the geographical range of just-in-time-contracting (due to different time zones).

The high number of established contracts can require special legal context for a micro-contract, as companies cannot afford traditional measures for contract arbitration and enforcement \[50\]. With traditional legislative practices, the cost for resolving a single micro-contract can be significantly higher than the benefits from the contract itself. The high automation of the enactment process in enactment-contracting requires specific, highly automated legal support for this paradigm as well. This is recognized
also in the European Directive on Electronic Commerce 2000/31/EC of the European Parliament and Council [24]: “Member States shall ensure that, in the event of disagreement between an information society service provider and the recipient of the service, their legislation does not hamper the use of out-of-court schemes, available under national law, for dispute settlement, including appropriate electronic means”.

From Table 3 it can be noticed that the employment of some of the paradigms sets more requirements on the contracting context than others. Micro-contracting, just-in-time-contracting and enactment-contracting have high requirements on the contracting context. As a result these paradigms can be employed in less business relations. On the contrary, management-contracting can be applied in any contracting context. This broad applicability of the management-contracting paradigm is one of the reasons that most of the existing projects and solutions in the e-contracting domain (e.g., [21], [23]) concentrate on supporting this paradigm.

5.2.3 What

During contract enactment, products or services are exchanged for the corresponding financial reward. The financial reward is part of every non-barter contract (see Table 4). As barter contracts are a small and specific class of contracts we do not pay special attention to them in our work. The micro-contracting paradigm requires support for specific payment techniques, e.g., micro-payments. Support for automated payments will be required in the enactment-contracting paradigm.

We make a distinction between standard exchanged values, which are produced irrespective of consumer specifications, and custom exchanged values, which are produced to satisfy specific consumer requirements (for reasons of simplicity we consider only the two extremes points, though standard values may be parameterized to allow some flexibility and custom values may be based on specific standards). The exchanged values are accompanied by a description of the value delivery and the conditions for it (this description is presented in the contract in the form of different provisions).

<table>
<thead>
<tr>
<th>Financial reward</th>
<th>Product</th>
<th>Service</th>
<th>Delivery description and conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Standard</td>
</tr>
<tr>
<td>µ-c M</td>
<td>MR</td>
<td>C</td>
<td>C</td>
</tr>
<tr>
<td>τ-c M</td>
<td>M</td>
<td>C</td>
<td>-</td>
</tr>
<tr>
<td>π-c M</td>
<td>M</td>
<td>C</td>
<td>C</td>
</tr>
<tr>
<td>ε-c M</td>
<td>MR</td>
<td>C</td>
<td>-</td>
</tr>
<tr>
<td>γ-c M</td>
<td>M</td>
<td>C</td>
<td>C</td>
</tr>
</tbody>
</table>

Table 4 – Exchanged values in the e-contracting paradigms

Standard products can be exchanged in all of the e-contracting paradigms. Micro-contracting for customized products is not sensible, as the efforts for customization of a product and its production for small business relations is not
economically reasonable. Custom products are not suitable for just-in-time-contracting, as there is no time for elaborate negotiations and thus for product customization. Custom products are not suitable for enactment-contracting as well. Automation of production control or service delivery control aimed at satisfying the requirements of a single contract is not economically reasonable. Traditional human “link” between contract establishment and contract enactment will be suitable enough in this scenario. Precision- and management-contracting can be applied for custom products, providing high quality contracts and their proper management.

With the same line of reasoning, it can be seen that standard service can be contracted in any of the paradigms. For the same reasons like in custom products, custom services are not suitable for just-in-time-, micro-, and enactment-contracting.

The description of the value delivery and the conditions for the delivery can be present in the contract content in micro-, just-in-time-, and management-contracting. There are no specific requirements on them in these three paradigms. For precision-contracting, the provisions related to the value exchange must be subject to automatic verification for consistency and correctness. Provisions that do not satisfy this requirement have to be avoided. Enactment-contracting is related to the automatic control of the contract enactment. This requires the provisions to be automatically interpretable in this paradigm. Similarly, management-contracting requires the usage of provisions that can be automatically managed.

It can be observed from Table 4 that e-contracting is mostly suitable for standard products and services. This fact is due to the high process automation required in each of the paradigms, which limits the possibilities for customization of products and services.

### 5.2.4 HoW

The means for contract establishment and enactment form the largest group of e-contracting concepts. That is why we use two separate tables to indicate relations between the concepts and e-contracting paradigms. First, we relate the e-contracting phases to the different paradigms. Next, we discuss the rest of the concepts (contract representation, content, structure, communication, and standards). As the e-contracting concepts from the HoW group describe the means for contract establishment and enactment, the requirements on the e-contracting concepts identified in this section are in fact requirements on the e-contracting information technology. These requirements serve are a starting point for the work presented in Section 6.

E-contracting comprises four basic phases, i.e., information, pre-contracting, contracting, and enactment phases [4], [5]. The first two phases are optional and activities from these phases can be executed when the business context requires this. The last two phases must be performed in all e-contracting processes, as in these phases, activities that are fundamental for the e-contracting process, i.e., for reaching contract agreement and its enactment, are performed. Following the agreed notation, in Table 5 the information and pre-contracting phases are denoted with “C” and the contracting and enactment phases with “M”.

As we have shown in Sections 4.1.6 (see Figure 3), the micro-, just-in-time-, and precision-contracting paradigms aim at improving different aspects of the contract establishment process. Thus, we can expect specific requirements from these three paradigms on the information, pre-contracting and contracting phases. Similarly, as the enactment- and management-contracting paradigms aim at improving contract enactment, we can expect requirements on enactment phases.

The information, pre-contracting, and contracting phases require specific support in the micro-contracting paradigm for the cheap and easy identification of matching offers, preparing for the contracting process and for the subsequent contract establishment. Consequently, information technology requirements on these three phases exist. As micro-contracts are about an exchange of products or services of low value, cheap means for conducting payments of low value (e.g., micro-payments) are required in the enactment phase.

Just-in-time-contracting allows fast contract establishment. Parties have to be able to find matching offers and to evaluate these offers in a few seconds. This imposes certain requirements on the first three e-contracting phases.

Precision-contracting aims at the contract content improvement. As the contract is negotiated in the contracting phase, special support for the creation of consistent contracts clauses and parameters is required in this phase. This paradigm is oriented towards improvements only in the contracting phase and for this reason, in contrast to the first two paradigms, no specific support is required in the information and pre-contracting phases.

Enactment-contracting requires support for the automatic contract enactment to be present in the enactment phase. Additionally, support for the machine-readable representation of the contract content is required in the contracting phase. Similar to enactment-contracting, management-contracting requires the contract to be in an interpretable form so that it can be automatically managed. This sets requirements on the information technology in the contracting phase. Naturally, specific technology for the automatic contract management is required as well. Thus, requirements on the contracting and enactment phases exist for the employment of management-contracting paradigm. For the support of management functionalities related to the contract conception (e.g., decision to initiate the contracting process), management-contracting sets requirements on the information phase as well.

From this brief analysis, it can be seen that employment of all five e-contracting paradigms together results in requirements on each of the e-contracting phases. Consequently, as we discuss in Section 6, this leads to high complexity of the
information technology involved in an e-contracting process. Furthermore, it can be noticed that each of the paradigms sets its own requirements on the contracting phase. This shows that creating the information technology required for the support of the contracting phase in the case of employment of all paradigms together will be a challenging task. The precision-contracting paradigm is the only paradigm that sets requirements on solely one e-contracting phase. In this respect, it can be expected as the easiest (in terms of technology) to employ paradigm.

Next, in Table 6 we relate the rest of the HoW concepts to the e-contracting paradigms.

<table>
<thead>
<tr>
<th></th>
<th>Content</th>
<th>Representation</th>
<th>Structure</th>
<th>Communication</th>
<th>Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>μ-c</td>
<td>M</td>
<td>MR</td>
<td>MR</td>
<td>MR</td>
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<tr>
<td>π-c</td>
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<tr>
<td>ε-c</td>
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<td>γ-c</td>
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</tbody>
</table>

Table 6 – HoW concepts in the e-contracting paradigms

All e-contracts must have content that represents the agreement of the parties, regardless of the employed paradigm.

In micro-contracting, contract establishment has to be cheap which requires cheap interpretation of the contract content during possible negotiations. This leads to requirements on the contract representation and structure, i.e., contracts must have representation and structure that can be automatically interpreted. Communication between parties must be cheap as well. The contract representation, structure, and communication must be supported by official standards that provide standard contracts and protocols, allowing cheap contracting between parties to be achieved (an example of a supporting standard for e-contracting is discussed in Section 7.1).

Just-in-time-contracting also assumes the use of standard contracts for the contract content, as there is no time for creation of specific contracts. Similar to micro-contracting, contracts in just-in-time-contracting must have representation and structure that can be automatically interpreted. Communication between parties in just-in-time-contracting has to be highly synchronised and automated for the establishment of contracts in a split second. Standards have to provide the required standard contracts and proper communication protocols for the fast contract establishment.

In precision-contracting, the contract must have structure and representation that will allow verification techniques to be applied on it on a clause or lower level. Contract templates, standard contracts, Standard Contract Clauses (SCC), or smaller contract structures (e.g. contract parameters) can be used to assist parties for the application of verification techniques. Verification of free-text contracts requires manual transformation of the contract content to an agreed rule syntax, after which contract verification can be performed. This process, however, is extremely time and labour demanding and its applicability is questionable. There are no specific requirements on the communication between companies in this paradigm.
In enactment-contracting, the contract must have a representation that can be automatically interpreted by the enactment system. The contract structure also facilitates the automatic interpretation of the contract. If communication between parties is required during contract enactment, standards that govern the communication protocol between the enacting systems (e.g., [35]) and the corresponding information technology are required. Standards for the contract representation are required as well. Management-contracting, similar to enactment-contracting, sets specific requirements on the contract representation and structure, which are supported by standards, so that the contract content can be automatically interpreted and managed. Standards that support the contract representation, and its structure, are required.

In this section, we have described the relations between the e-contracting paradigms and the e-contracting concepts from the 4W framework, identifying the e-contracting concepts involved in the employment of a paradigm and the requirements on these concepts. In the following section (Section 6), we go one step further and discuss the applications required for e-contracting, paying attention to their specifics in each of the e-contracting paradigms.

6 Required technologies for the support of deep e-contracting

Until now, we have described the e-contracting paradigms and their relation to the different e-contracting concepts. In this section, we discuss the technological support required for e-contracting. First, we describe a reference e-contracting architecture. Next, we depict required basic applications for the support of this e-contracting architecture. Finally, we use the identified requirements of paradigms on the different e-contracting concepts to identify the specific requirements on the e-contracting technology in each of the e-contracting paradigms.

6.1 Reference e-contracting architecture

An e-contracting system has to support a number of different functionalities throughout the e-contracting process [47]. We use as a source for identification of these functionalities an e-contracting process model that we have previously elaborated [5]. Each activity from this model sets requirements on the e-contracting system for its support. We have grouped together activities that lead to similar functionality requirements. The identified functionality requirements are used to identify and define the components of the e-contracting architecture that should support these functionalities.

Efforts to define an e-contracting conceptual architecture already exist [49], [11]. However, these efforts were not based on a detailed e-contracting process model and thus the resulting architectures are not complete and well-founded. The architecture that we discuss in this section aims at describing the commonalities and differences between the technology requirements of the e-contracting paradigms. To achieve this, an abstract description of the reference architecture suffices. A more detailed architecture is required for the implementation of an e-contracting system. We consider this as part of our future research work.
On the basis of our e-contracting process model, we have identified the following components of an e-contracting architecture: match maker, advisor, negotiator, validator, monitor, manager, wrapper and enactor, evaluator, and storage container (see Figure 6). The components of this reference e-contracting architecture are identical at the consumer and supplier side. Thus, in Figure 6 Company A can be either a consumer or a supplier. As Company B supports the same components, they are not represented in Figure 6. In addition, we have identified a number of components that has to be supported by intermediaries, i.e., external match maker, notary, arbitrator, reputation center, and repositories. The list of components supported by intermediaries in Figure 6 is not complete. It can significantly vary depending on the context and is aimed only at illustrating the types of support provided by intermediaries. A more detailed description of the components supported by intermediaries is provided in [50].

Next, we briefly describe the identified components and their usage. We relate each of the components to the e-contracting phases that it supports and the e-contracting concepts that it uses (see Section 5.2). At the end of this section, we discuss which components are required for each of the e-contracting paradigms.

**Match Maker**

The Match Maker component supports the discovery of possible trading parties. The Match Maker identifies matching requests and offers of the companies based on the *exchanged value* and its *delivery description and conditions* (see Section 5.2.3). The output of the Match Maker is a set of one or more possible business partners with offers or advertisements that satisfy the
requested criteria of the company. If no partners are found for a certain period of time, the Match Maker can be stopped, which leads to abortion of the e-contracting process due the lack of trading opportunities. The Match Maker supports the execution of the information phase of the e-contracting process. It can interact with a number of intermediaries that provide repositories for advertisements and offers, and with other parties (consumers or suppliers). The Match Maker component can be implemented by an intermediary as well (i.e., the External MM component). In this case, instead of the Match Maker component, companies should have a simple publishing component (for publishing requests and offers).

Advisor
The Advisor component is responsible for the performance of any pre-negotiation activities. As soon as one or more possible partners have been identified by the Match Maker, the Advisor component can start evaluating them and their offers. It should be able to collect additional data about the parties (e.g., through Reputation Centers), request for up-to-date offers, and perform other activities that can facilitate the evaluation of the trading opportunities. The Advisor produces as an output one or more parties which it recommends as potential partners and with which negotiations on a contract can be started. The Advisor component should be able to rank the recommended contracting parties, depending on the preferences of the company. For example, if trust is a more important aspect than money, parties with higher reputation can be ranked higher, though their offers might be less financially advantageous. The Advisor component supports the execution of the pre-contracting phase.

Negotiator
The Negotiator component performs the negotiations on the e-contract content (see Section 5.2.4). It uses the recommended by the Advisor companies and starts negotiations with one or more of them. The Negotiator can use contract templates, standard contracts, standard clauses, rules on use of contract clauses, etc., retrieved from the Storage component or from an intermediary repository. The output from this component is one or more e-contract agreements. When negotiations are not successful, the Negotiator informs the company for the failure. Different negotiation approaches and techniques can be applied in the Negotiator, depending on the business context and preferences of the company. The Negotiator supports part of the contracting phase.

Validator
The Validator supports the contract validation. Contract validation includes activities related to the control of the agreement for compliance with legislative requirements, internal company requirements, domain specific requirements, and technology requirements. The output from this component is a valid e-contract. The e-contract can be stored in the Storage component and/or in the storage of a third party (e.g. Notary). The Validator supports part of the contracting phase.

Manager
The Manager component is responsible for the management of the e-contracts of a company. It indicates when a contracting process has to start, when the contract enactment and monitoring should start, when certain activities have to be performed (e.g., contract renewal), when a deadline is approaching, etc. The Manager component receives data from the Monitor component that observes the parties behaviour. Based on the data received from the Monitor and
the e-contract, the Manager can send instructions to the Enactor component (e.g. for starting an activity), to the contracting party (e.g., to notify it for a contract breach), or to an intermediary (e.g., an Arbitrator). The Manager performs part of the activities in the *enactment* phase. It supports some smaller functionalities of the information phase as well.

*Monitor*

The Monitor component monitors the contract enactment. It can use three sources of data, i.e., the e-contract that contains *delivery description and conditions* provisions and other context related *provisions* (see Sections 5.2.3 and 5.2.2), the data provided from the Enactor component, and the data provided from the contracting party. Based on these three sources, the monitor evaluates the contract enactment performance and informs the Manager component on the current status of the enactment process. The Monitor performs part of the activities in the *enactment* phase.

*Enactor and Wrapper*

The Enactor component manages the performance of the activities agreed in the e-contract. It is the orchestration system of the company that manages the delivery of the values stated in the e-contract and the activities related to it (e.g., it can be a WFMS, or an ERP system). In simpler businesses, the Enactor can be merely the service provision application. The Enactor component uses the e-contract and the data received from the Manager for the service or product delivery. Companies can use various orchestration and backend systems. However, the contract specification language has to comply with a commonly accepted standard. For this reason, we suggest a Wrapper component around the Enactor component. The Wrapper has to map the data provided in the e-contract to the specific format supported by the Enactor. The Enactor and the Wrapper support part of the activities in the contract *enactment* phase.

*Evaluator*

The Evaluator component uses the data provided by the Monitor, Manager, and Enactor and the e-contract content to evaluate the contract performance. The evaluation is stored in the internal Storage component for future contract relations. It can be sent to an intermediary as well (e.g., to a Reputation Center). This component supports part of the activities in the contract *enactment* phase.

*Storage*

The Storage component is used to store the current and archived e-contracts, data related to them, advertisements, offers, rule for the contract content, standard contracts, contract templates, process specifications, etc. The storage component is used throughout all e-contracting phases.

For the employment of a specific e-contracting paradigm, only some of the components in Figure 6 will be used. For example, if the enactment-contracting paradigm is not employed, the wrapper and enactor components will not be required. Similarly, if the management-contracting paradigm is not employed, the manager, monitor, and evaluator components will not be necessary. In order to provide a reference architecture that can be used in the design of e-contracting systems employing any of the e-contracting paradigms, we have depicted in Figure 6 all components and the communication channels between them. In Table 7 we show which components are required (“R”) for the employment of the separate paradigms. Table 5 (see
Section 5.2.4 provides the requirements of the paradigms on the information technology in each of the e-contracting phases. In the description of the reference architecture components, we have stated which components are used for the support of the separate phases. Using these two sources and the definition of each of the e-contracting paradigms, Table 7 can be easily constructed.

<table>
<thead>
<tr>
<th>Inf. phase</th>
<th>Pre-contracting phase</th>
<th>Contracting phase</th>
<th>Enactment phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Match Maker</td>
<td>Advisor</td>
<td>Negotiator</td>
<td>Validator</td>
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<tr>
<td>µ-c</td>
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<td>γ-c</td>
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</tbody>
</table>

Table 7 - Required components in the e-contracting paradigms

It can be noticed from Table 7 that the Negotiator component is required for the employment of any of the e-contracting paradigms. For the contract establishment related paradigms this is obvious. The reason to require this component for the contract enactment related paradigms is that both the enactment- and management-contracting paradigms require machine interpretable contract content. This can be achieved only if the negotiations are supported by information technology. In Table 7, the Manager component is shown as required only for the support of the enactment phase. However, as we have already discussed, contract management requires this component to support certain functionalities in the information phase as well (see Section 5.2.4).

6.2 General e-contracting information technology

Two classes of information technology that is involved in an e-contracting system can be distinguished, i.e., basic technology and component specific technology. The former class of technology includes applications that provide basic support for the e-contracting process and can be used by different components of the reference architecture. The latter class of technology provides support for specific components of the reference architecture. In this section, we discuss the software technology that is required for the employment of more than one of the e-contracting paradigms, i.e., general e-contracting technology. We start with the description of the basic technology. Next, we discuss component specific technology. We describe the paradigm specific technologies in Section 6.3.

6.2.1 Basic technology

We identify four types of basic technology, i.e., document management, process management, document transfer, and security technology. Next, we discuss each of these technologies.

Document management support
E-contracts, offers, advertisements, and other electronic documents are exchanged during e-contracting. Companies make use of contract templates, previously established
e-contracts, and contract evaluations. These documents have to be stored and retrieved when required. Document management support is required by several components of the e-contracting architecture. For example, the Match Maker uses advertisements and offers to find parties that match the trading requirements. The Negotiator uses contract templates and previously established contracts during negotiation. All exchanged versions of e-contracts during negotiation have to be stored and indexed for traceability reasons. Finally, the agreed contract has to be stored as well. All these documents have to be stored in one or more databases. XML answers to the requirement for document structuring and has become the de facto standard for e-contracts and related documents [44], [25]. As a result, a XML enabled database management system (and related XML query languages like XML-QL [19]) is required for storage and retrieval of data during e-contracting. The DBMS is represented in Figure 6 as the Storage components. Data warehousing techniques [18] can be of relevance in many contract intense businesses.

Process management support
Process management is required for the support of the e-contracting process (the four e-contracting phases) to achieve the required levels of efficiency. Depending on the context, the e-contracting process can change, e.g., certain activities can be skipped, added, executed in different order, or different number of times [5]. Additionally, as companies can have a number of contractual relationships, management of the different e-contracting processes is required. Workflow management technology [45] is applicable to provide an infrastructure for integrated process management across the individual contracting activities and the different e-contracting processes. Different workflow management systems are currently available on the market (e.g., WebSphere MQ Workflow (formerly MQSeries Workflow) [36], Staffware [62], eFlow [13]) and their improvement is being researched [1]. Businesses that operate within a stable network of partner companies (e.g., companies in the automotive business) can make use of cross-organizational workflow technology [26], [32] to integrate their business processes. The initial investments required for the alignment and coupling of the internal workflows can be justified in a longer term. Cross-organizational workflow technology is still under research (e.g., [15]). The Workflow Management Coalition [35] governs the standardization efforts in this domain.

Document transfer support
In Figure 6 many communication channels inside as well as outside the company are shown. These communication channels are used for the exchange of messages and documents using an agreed protocol. Different protocols can be used for the document and message exchange. The SOAP protocol (a protocol based on the HTTP and XML protocols) is an example of a standard for information exchange [61].

Security support
E-contracting involves the exchange and storage of messages and documents with high privacy and importance. This requires secure means for the document management and transfer. Digital signature systems [53] are of indispensable use to guarantee the four security issues, i.e., authentication, privacy, integrity, and non-repudiation [63]. In
addition, advanced digital signing is required for the signing of the agreed contract. Advanced digital signatures should be a specific type of digital signatures showing that the signed document is legally binding. This differentiation of digital signatures is caused by the need to differentiate legally binding signatures from digital signatures used only by security considerations. The advanced digital signature is used by the Negotiator for the signing of the legally binding e-contract offers, the final e-contract and if necessary of other legally binding documents.

6.2.2 Component specific technology

From Table 7 it can be noticed that the Negotiator is a components required in all e-contracting paradigms. The Match Maker and Advisor are components that are required in several e-contracting paradigms. The Match Maker and Negotiator components have been identified as required components for e-commerce since its dawn. This has caused attention to be paid to these two components, which has lead to their (limited at this time) support. However, the Advisor component is strongly e-contracting specific. This component is new and still not widely accepted. For this reason, to the best of our knowledge, no applications for its direct support exist.

Match Maker support

A matchmaking application is required to support the Match Maker component of the e-contracting architecture. Research on matchmaking systems in the e-commerce domain has been carried out (e.g., [9], [30], [34]). Examples of existing matchmaking systems are the ODP/CORBA Trading service [54], and the IBM WebSphere Matchmaking Environment (WME) [65]. However, the lack of commonly accepted standards leads to a diversity of offer and advertisement formats used by companies and hinders the broad implementation and usage of these systems.

Negotiator support

A negotiation application is required for the support of the Negotiator component. There are two aspects of the negotiation application. The first aspect is the support for a negotiation protocol between parties. The second aspect is the support for negotiation decisions, i.e., Negotiation Support Systems (NSS). While in some business scenarios the protocol support will be sufficient, others will require support of both aspects. Negotiation protocols are discussed in [7] and [40]. Rule based systems (discussed in [64]) are the existing class of technology used for the support of the negotiation decisions. Depending on the business context, e.g., type of exchanged value, or e-contracting paradigm, different approaches and combinations of technologies for the implementation of the Negotiator can be put into practice. Rule based systems can be applied separately or in combination with agent systems, auction systems, etc., using a negotiation protocol as a basis. An analysis of the existing approaches is provided in [8] and [48]. A general framework for automated negotiation is presented in [7]. Its implementation is based on the Jade multi-agent platform and the Java Expert System Shell [41]. Other existing negotiation support systems are, for example, Inspire, INSS, and Danse [39].
**Advisor support**

The Advisor component must support a complex functionality in the e-contracting architecture and as a result it requires the use of several types of technology. An application supporting the Advisor component can be using rule based systems (e.g., Decision Support Systems) for evaluating and ranking the possible contracting parties. Data mining techniques can be used to analyse the characteristics of current and previous contracts, providing input for strategic decisions with respect to the choice of business partners. In addition, an Advisor application should be able to collect extra and up-to-date data about the parties in order to provide most relevant advice.

### 6.3 Paradigm specific requirements on information technology

In Sections 6.1 and 6.2 we have described a reference e-contracting architecture and the information technology that is required for its general support as well as the component specific technology common for several paradigms. Each paradigm adds specific requirements on the e-contracting information technology. In this section, we discuss the information technology that is specific for the employment of a paradigm. We discuss the specific requirements of the paradigms on the general information technology described in Section 6.2. Likewise, we investigate the existing technology required for the support of the components specific for a single paradigm. To achieve this, we use as a starting point Table 7 (see Section 6.1), which lists the components that are required for each paradigm. Table 7 indicates that there are five components from the reference architecture that are required in only one of the paradigms, i.e., the Validator, Manager, Monitor, Enactor, and Evaluator. The technology for the support of these paradigm specific components is discussed in the corresponding paradigm below.

#### 6.3.1 Information technology requirements for micro-contracting

Micro-contracting is characterized with the possibility to establish high numbers of customized e-contracts. Consequently, micro-contracting sets specific requirements on the document management supporting technology. Document management supporting technology in micro-contracting has to be extended in the Negotiator component to support data warehousing techniques for the management of the high number of established and further on archived contracts and the accompanying related documents. Efficient and scalable process support for the automatic establishment (often simultaneous) of the high number of customized contracts is required. Additionally, cheap communication is an issue for the establishment of low value exchanges. As we have noticed in Section 5.2.4 e-payments and specifically micro-payment technology are a basic requirement for the micro-contracting paradigm.
6.3.2 Information technology requirements for just-in-time-contracting

Just-in-time-contracting requires from the supporting applications to provide high speed and reliability of the contract establishment process. Completely automated matchmaking, party selection and negotiation are necessary for the just-in-time-contracting paradigm. In this paradigm, the published advertisements, offers, etc., should be up-to-date and reliable. This requires constant maintenance to be implemented in the storage components of the contracting companies and repositories of the involved intermediaries (regular updating of the current offers, removal of old offers, etc.). Fast and reliable communications must guarantee the possibility of fast contract establishment in the chosen moment. Additionally, less flexible but faster negotiation algorithms and reliable negotiation protocols are required in the context of this paradigm.

6.3.3 Information technology requirements for precision-contracting

From Table 5, we can see that precision-contracting has requirements on the contracting phase. The Negotiator application has to be extended to check and prevent the inclusion of inconsistent contract clauses and parameters. Additionally, the Validator component has to provide support for the contract validation (i.e., to guarantee compliance with the internal and external contract content requirements). Contract verification and validation applications can be based on the four basic types of business rules, i.e., integrity, derivation, reaction, and deontic assignments rules [64]. Popular languages for development of rule systems are Prolog and the Java Expert System Shell (JESS) [41]. Examples of existing commercial systems for development of rule-based applications are ILOG JRules [56] and BizPulse [10]. An application under development that aims at supporting the precision contracting paradigm is the Open Contracting Services (OCS) Contract Editor [58]. In its current version, the Contract Editor provides limited support for contract construction (based on contract templates and derivation rules), negotiation, validation, and signing.

6.3.4 Information technology requirements for enactment-contracting

Enactment-contracting requires coupling between the Negotiator and the Enactor components. A mapping technology (denoted as Wrapper in Figure 6) is needed to map the contract content to the specific format that can be interpreted and enacted by the enactment system. Such technology is highly context specific and should rely on standards established for the contract content representation. In [28], a three-level framework that supports the coupling between the external process specification provided by the Negotiator and the internal specification required by the Enactor is suggested. The Enactor can be implemented with commercially available (off-the-shelf) applications or with dedicated applications. In more complex situations, the Enactor might have to exchange data with the Enactor component at the partner side. In these cases, Web Services and Web Service composition (e.g., through BPEL [12]) or cross-organizational workflow technology can be used to support the enactment-contracting paradigm. In the CrossFlow project [15], the established e-contracts contain an external, system-independent workflow specification of the processes to be performed.
This specification has its corresponding, detailed, internal representation that can be interpreted by the supporting workflow system (i.e., the Enactor) [32].

6.3.5 Information technology requirements for management-contracting

A monitoring application is required to support the contract monitoring and management. This application provides the functionalities required from the Monitor component. This type of application is still in its infancy for this domain. Research projects are carried out for example in [66] and [25]. In [50], the Web Services standard is used for the implementation of the management and monitoring support. Limited applications are currently available for example from DiCarta [20], Contracto [14], Oracle [55], and SAP [60]. However, these applications are an integral part of the underlying proprietary systems. Rule based systems (e.g., Management Support Systems and Decision Support Systems) can be used for the support of the Manager component. The Manager component has to support handling of contract breaches (e.g., assessing the level of breach and required measures), tracking of the currently enacted contracts, decision making for contract renewals or for establishment of new contractual relations, etc. A possible algorithm for the handling of contract deviations is presented in [50]. Similarly to the Advisor component, rule systems and data mining techniques are of high relevance for the Evaluator component. Applications implementing the Evaluator component should be able to evaluate the contract performance, based on violations detected during the contract enactment, and on comparison of the activities that are actually performed and those that are agreed in the contract.

7 Overview of research and standardization work with respect to the different paradigms

In this section, we investigate the support for the different paradigms in existing standardization efforts and research projects. From the existing standardization efforts, we have chosen ebXML, which is a standardization effort supported by OASIS and UN/CEFACT (United Nations Centre for Trade Facilitation and Electronic Business). Compared to other standardization efforts, ebXML has the broadest goals. It is intended to replace the EDI standard, which is the current standard for electronic trading. From the existing research projects, we have selected two advanced research projects in e-contracting, i.e., CrossFlow and Elemental. CrossFlow is a well-known project that has provided significant results for the support of contracted cross-organizational workflows. The Elemental project is a continuation of the research work on e-contracting that has been conducted for several years at the University of Queensland and the Distributed Systems Technology Centre. This research work has delivered one of the first results in the field of e-contracting [49], and is renowned for its results.
7.1 ebXML

ebXML is a standardization effort that provides a framework for doing business through electronic means [22]. In [6], we have positioned the ebXML standardization effort in the 4W framework and have concluded that it can support e-contracting in its various forms and contexts. Next, we examine its support for deep e-contracting. We use the results from Sections 5.2.4 and 6 to identify where ebXML as a standard is required to support each of the paradigms.

With respect to the general requirements on an e-contracting system, ebXML falls short at providing standards in several directions. A Match Maker component is missing in the ebXML framework to support automatic matchmaking required by the e-contracting paradigms. A repository in which standard contracts, templates, offers, etc. can be stored and a registry where companies can publish their profiles are present. However, there are no standards that can facilitate the automatic matching of these profiles. The Negotiator component is missing as well from the ebXML architecture. Several negotiating patterns that can be used by parties are described in the standard. In the ebXML architecture no attention is paid to specific e-contracting components like the Advisor, Validator, and Evaluator components from our e-contracting reference architecture. Consequently, there are no standards in ebXML that can support applications implementing these components. A messaging service that provides a communication standard between the contracting parties is part of the ebXML framework. A security model applied on the entire ebXML infrastructure is present as well.

With respect to the specific paradigms, ebXML falls short in providing standards required by some of the paradigms as well. ebXML does not provide standard contracts as demanded by micro-contracting. The responsibility for the elaboration of standard contracts and templates is left out to the market participants. The just-in-time-contracting paradigm requires a high level of automation of the information and contracting phases for the fast contract establishment. At present, the process for contract establishment based on the Collaboration Protocol Profiles (CPPs) of the parties is vaguely defined and it cannot be judged if just-in-time-contracting can be supported even in a limited form in the ebXML framework. ebXML does not provide any specific for the precision-contracting paradigm standards. The standards provided for the structure of the Collaboration Protocol Profiles and the Collaboration Protocol Agreements are too general to provide possibilities for advanced contract management. However, based on the ebXML standard, basic contract management is possible, e.g. start and end of the agreement. ebXML provides a standard for process descriptions in the contract content (called Business Process Specification Schema). Using this description, contracts can be automatically enacted. Thus the enactment-contracting paradigm can be employed in situations that allow specification of the business process.

From this brief overview, we can conclude that ebXML provides standards for limited employment of the micro-management- and enactment-contracting paradigms. The ebXML architecture requires additional standardization efforts for the full support of the deep e-contracting paradigms. For example, additional standards for the contract clauses and relations between them and the matching of offers must be supplemented. Thus, a system that is based solely on the ebXML framework will not be able to support all e-contracting paradigms.
7.2 The CrossFlow project

CrossFlow is an ESPRIT project [15] that addressed the support for cross-organizational workflow management in virtual enterprises [26]. It was successfully completed in the end of year 2000. The project aimed at supporting dynamic workflow service outsourcing within a service consumer/supplier context. In CrossFlow, it is possible to use standard contracts and partially filled contracts. This, and the high level of automation, due to the use of advanced information technologies (e.g., a Match Maker Engine) allows the micro- and just-in-time-contracting paradigms to be supported (as we have mentioned in Section 4.3.1, the logistic scenario used to illustrate these two paradigms has been created as a business case in the CrossFlow project). However, no real standards are used in the project for the implementation of these paradigms (e.g., for the offers and contract templates). In CrossFlow, the contract content is machine-readable (represented in XML) with an option for a human-readable section. This allows contracts to be managed automatically, and in this way to employ the management-contracting paradigm. As the project is specialized in dynamic workflow service outsourcing and has a machine-readable contract representation, contracts can be executed automatically by the supporting workflow systems (employing the enactment-contracting paradigm). However, the business scenarios discussed in the project are based on physical business processes. As a result, completely automated contract enactment is not described in the project.

The CrossFlow system is capable of supporting four of the five e-contracting paradigms in a limited business context. The limitations result from several factors. First, the conceptual architecture described in the project is in the context of cross-organizational workflow management. In this way, the management- and enactment contracting paradigms are considered only in the context of this technological environment. Additionally, the project does not rely on existing standards for the support of any of the paradigms. This leads to limitations in the employment of the micro- and just-in-time-contracting paradigms in a broad context. The precision-contracting paradigm is not considered in the project, as it requires specific support in the contracting phase, and is outside the scope of the business scenarios considered.

7.3 The Elemental project

The Elemental project [23] aims at elaborating business contract models that can be used for the higher level of automation of the contract management process. The project uses as a foundation of its research work a previously defined Business Contract Architecture (BCA) [49].

In the Elemental project, the use of contract templates, standard contracts and a repository for their storing is envisaged. However, no specific attention is paid to the information phase of the e-contracting process. For example, a Match Maker component is missing in the BCA. Additionally, automatic contract negotiation is not considered in the context of the project. That is why micro-contracting can be supported only in a limited way, i.e., for contracting with already known contracting parties and with little or no need for contract negotiation. For the same reasons, just-in-time-contracting cannot be fully supported.

The project concentrates on the contract monitoring and enforcement during enactment. A possible solution for structuring of the contract content has been proposed [51]. Structured contracts can be automatically interpreted and monitored and enforcement measures can be
applied if necessary [50]. Thus, the contract-management paradigm can be employed in the context of the Elemental project. Possibilities for checking of contract consistency are discussed in [51]. However, support for precision-contracting is not in the priorities of the project. The contracting system of the project should support major ERP systems. This should allow enactment-contracting to be achieved for some business cases. However, at this stage of the project, we cannot estimate the level of coupling of the contracting system with concrete internal enterprise system.

The Elemental project concentrates mainly on the support of the management-contracting paradigm. It can be expected that the e-contracting system developed in the Elemental project will be able to provide limited support for the employment of the enactment-contracting paradigm.

8 Conclusions

A justification for the application of information technology in an enterprise application must be based on one of the conditions: it should improve the performance of the existing organization, or it should improve the chances of success for new business opportunities and strategies [56]. E-contracting can be applied to solve cost, time, complexity, etc. problems that occur in paper contracting. Furthermore, as we have shown throughout the paper, e-contracting can provide new opportunities to the contracting parties. Thus, e-contracting responds to both requirements for application of information technology in a business. This is a clear indication for the importance of e-contracting technology in the modern business.

Currently, e-contracting is a topic of interest for both industry and research world. However, this topic is often addressed in a non-systematic manner. Different understandings of the concept of e-contracts exist. This leads to different expectations from e-contracting systems. A clear and complete description of the aspects of traditional paper contracting that can be improved through e-contracting is missing. As a result, though all the existing work on e-contracting aims at automation of the process of contracting, the level and aspects of automation may differ significantly among the different projects.

In this paper, we provide a broad and structured representation of the e-contracting goals and the new opportunities introduced by it. Based on the level of automation of the contracting process, we define two basic classes of e-contracting, i.e., shallow and deep e-contracting. We identify and discuss five paradigms for deep e-contracting: micro-, just-in-time-, precision-, enactment-, and management-contracting. The previously defined 4W e-contracting framework is used to investigate the requirements of the e-contracting paradigms on the e-contracting concepts. We provide a general e-contracting architecture and the required information technologies for its support. Additionally, we investigate what the specific requirements of each of the paradigm towards the general architecture and the supporting information technologies are. In this way, we achieve a broad description of the requirements of the e-contracting paradigms.

The management-contracting paradigm can be employed in all e-contracting contexts without any restrictions. Furthermore, micro- and enactment-contracting should be combined with the management-contracting paradigm in most e-contracting scenarios. This illustrates the broad and frequent application of the management-contracting paradigm. Precision-contracting is related to a small part of the e-contracting process and has low requirements on the information
technology. This indicates that this paradigm would easily be employed. The broad and frequent application of management-contracting, and the low technology requirements of precision-contracting are the reason many of the existing efforts in the domain of deep e-contracting to be oriented towards the support of the management- and precision-contracting paradigms [21], [58]. Micro-contracting, just-in-time-contracting, and enactment-contracting can be employed in a limited set of e-contracting scenarios. Micro-contracting sets requirements on the business, geographical, and legal contexts. Just-in-time-contracting requires specific business and geographical conditions, whilst enactment-contracting demands specific business and legal context. This leads to requirements on the supporting standards, which have to facilitate the employment of these paradigms. However, the limitations for the employment of these paradigms do not diminish their importance.

This paper defines the basic business and technological aspects of the e-contracting domain. The depicted set of benefits from e-contracting allows companies to determine the improvements that can introduce e-contracting in their business. The defined e-contracting paradigms are a foundation for the definition of new contracting and business strategies in an enterprise. The identified conceptual and technological requirements for employment of the e-contracting paradigms provide a starting point for projects in the domain of deep e-contracting.

Most of the information technologies required for the support of the paradigms are still not mature and their usage even for a single paradigm is a challenging task. The employment of several or all e-contracting paradigms increases significantly the complexity of the e-contracting architecture and requires coupling of highly complex technologies. Initially, companies would start with the employment of shallow e-contracting. However, with the development and maturing of information technologies, it would be possible for companies to support higher level of automation of the e-contracting process, including even combinations of e-contracting paradigms.

The work presented in this paper sets a number of research questions that we plan to address in our future research work. The provided general architecture has to be elaborated in greater detail. An e-contracting reference architecture has to be highly flexible in order to support the diversity of possible e-contracting processes that can be performed in each of the e-contracting paradigms. A detailed and flexible reference architecture will allow straightforward system design and implementation for the employment of one or more of the e-contracting paradigms with their specific requirements. We plan to evaluate our work by mapping the elements of the detailed reference architecture to existing information technologies and implementing it in a concrete business scenario.

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References


60. SAP. http://www.sap.com/.