Chapter 1
Motivation

The first section shall deliver an overall insight about this doctoral thesis. Section 1.1 gives a short introduction to the exchange of rights on goods or services within the scope of electronic commerce (short: e-commerce) and gives some examples of drawbacks that the current non-standardised e-commerce technology has. Section 1.2 then provides the theoretical background why standardised technology can improve and quicken e-commerce. In Section 1.3 the objectives of this doctoral thesis are defined. The subsequent section deals with the classification of this thesis into research theory (see Section 1.4) and introduce the research methods that have been applied. The first chapter closes with an overview of the overall structure of this thesis (see Section 1.5).

1.1 Introduction

The Internet has evolved as worldwide e-commerce platform for digital goods. Technically, digital goods are any kind of information that can be digitised, such as baseball scores, books, databases, software, magazines, movies, music, stock quotes, and web pages [SV99]. Most of the existing digital goods did not evolve with the penetration of the Internet, but simply changed their medium from physical to digital. The digital medium offers a large spectrum of new ways for commercialisation [WIP02]. Ten years ago, for example, one obtained a certain song by buying the complete album for €10.00 in form of a compact disc or on vinyl, i.e. there was only one way to purchase this song, because it was bound to the medium of a compact disc. Producing a compact disc for each song on the album is far too cost
intensive and risky. By using the Internet as medium, these boundaries melt and it is possible to bring this song to market in various forms: as a single song for e.g. €1.00, in a bundle of 5 songs for €3.00, and with the restriction to play the song only five times for €0.50. The production costs of these three products are low, as the copying and bundling of digital goods is cheap.

The Internet gains increasing importance as distribution channel for digital goods [Bak98, Zhu01]. The distribution via the Internet is also cheap for the seller, as normally the consumer pays the carrier costs. People and companies from all over the world have business with each other trading both physical and digital goods. The basis for each business is a contract. Today’s electronic business works with electronic contracts concluded between two dislocated contracting parties that are not very transparent. An electronic contract is an agreement of two or more parties, on the exchange of rights to (digital) goods or services under certain terms and conditions. The memorandum of an electronic contract is digital and can be transmitted via an electronic network (see Section 4).

With a simple click, you can purchase a book, a song, a washing machine. What is missing, most times, is the contract information in a format that enables consumers, vendors, and third parties to reconstruct what exact product has been purchased, who the contract parties are, and which permissions and duties have been agreed on. Nowadays, contracts that are concluded via the Internet are either not explicitly stored or kept as database entries in a proprietary format, containing relevant information for the processing software system. For example, the EducaNext platform 1, a brokerage platform for learning resources, stores booking id, resource id, user id, and optionally a comment, after a learning resource has been booked. This fact has a number of drawbacks:

- People enter into proprietary contracts with each business partner. The non-standardised representation of terms and conditions is not transparent or comparable.

- The contracts can not be presented to or verified by a third person (e.g. a lawyer or a bank) because in most cases electronic contracts are ambiguous and/or not readable for humans.

- The contracts can not be exchanged between platforms that do not operate with the same software or did not agree on a common contract format.

1See: http://www.educanext.org/
Because of the non-standardised format of contracts, most times electronic contracts have to be fulfilled with the platform where they have been concluded. For example, one can not buy a contingent of 100 music units and spend it at arbitrary online music providers.

Contracts also contain valuable information for various business applications (access control, book keeping, customer relationship management, etc.). Today, most contracts are designed to be processed in a single application. Changing the contract structure or the contract content usually requires an adaptation of database tables and software.

In the pricing model (see Section 2.1) 'playing a certain music file 5 times for €0.50' the contract comprises the constraint information (play only five times). This information usually has to be interpreted by the digital player (also called secure viewer. To understand and enforce the constraint information, the player has to understand the proprietary format. As a result, today's online music shops all have their own player, to the displeasure of the customer.

Most likely, this is not a complete list of disadvantages, but it shows a number of severe drawbacks when using proprietary contracts. This thesis aims at giving a basis to reduce these disadvantages. To reason the objectives of this thesis more profoundly, the subsequent chapter describes the theoretical background to the advantages of deploying standardised electronic contracts.

1.2 The Impact of Standardised Contracts to Electronic Commerce

Electronic Commerce is the 'business activities conducted using electronic data transmission via the Internet and the world wide web' [SP00]. Several parties profit from e-commerce, e.g. consumers and providers of physical and digital goods: consumers benefit from accessing global markets for electronic and physical goods via the Internet. In turn, content providers can sell their products and services on global markets and in narrow market segments that may be geographically distributed [NJRW01]. Apart from providers and consumers, many additional actors will profit from e-commerce [Rig03], namely the actors in the business to business (B2B) context that are involved in the supply chain: e.g. actors in procurement,
content creation, content packaging, content publishing, content selling, content distribution, content consumption services, and customer relationship management [Sup03, Ian03b, Sun02, Ass00].

Cooperation among various actors in the supply chain results in a network of actors on the Internet. The term 'Metcalfe's Law', sometimes also called network effect, that was coined by Gilder [Gil93], states that the value of a network grows with the square of the number of participants. In other words, each additional member of a network adds an incremental amount of value to every other member, thus increasing the aggregate value of the network in a quadratic fashion, while the cost–per–user remains the same or even decreases. This means that actors cooperating in the supply chain build an e-commerce network that is more valuable than a number of isolated actors. For example, a number of content publishers found a consortium to offer their goods via a common portal and agree on using a certain payment method. If their customers trust this consortium and find the payment method comfortable and secure, a new member of the consortium will easily be accepted and trusted by the customer as well. The consortium reaches more customers by affiliating new members, and the customer has more products at the favorite content publisher portal to choose from.

In practice, organisations have aspired to achieve better collaboration with partners via interorganisational systems like electronic data interchange (EDI) that permit firms to exchange electronic information. However, most attempts have been focused on pairs of business partners rather than on providing an open standardised solution [CM03]. Such technology is hindering the network effect because a data interchange with all partners in a large community is not intended. Besides earlier attempts of cooperation have not been based on legally binding contracts which has caused increasing costs for managing collaboration and reduced its advantages [WBK03]. Accordingly, a general solution is required that facilitates the standardised data interchange of business to consumer (B2C), business to business (B2B), and also consumer to consumer (C2C). In particular, standardised contracts are required to state legally binding obligations between providers and sellers of goods and services in an electronic market [GSSS00], i.e. all actors in the supply chain.

To underline the importance of such standardised technology, the subsequent paragraphs will present studies that have investigated the perceived

---

2Attributed to Robert Metcalfe, originator of Ethernet and founder of 3COM
strategic value of information technology (IT) in general, the strategic value of e-commerce systems in particular, and the influencing factors to adopt e-commerce systems.

- **Strategic value.** In most studies the perceived strategic value of information technology focuses on the relationship between IT and the firm's performance. In [HE96] it was found that IT increases productivity and consumer surplus but not necessarily business profits. In [GP03] it is therefore concluded that "IT investments are important to maintain competitive parity but do not necessarily support competitive advantage". For e-commerce, as one particular field of a company's IT, [SS02] found that the most important area in which e-commerce will create value is in reducing transaction costs involved in bringing consumers and suppliers together. After reviewing a number of relevant studies in this field [GP03] identifies organisational support, managerial productivity, and decision aid as strategic reasons for e-commerce.

- **Technology adoption.** Statements on information technology adoption are often based on the Technology Acceptance Model (TAM) developed by Davis [Dav89]. In [LMSZ00] investigations based on TAM on different applications, such as e-mail, Internet, ATM, and MS Word, have been summarised. The results show that ease of use and perceived usefulness are the major factors that affect the intentions to technology use. Perceived benefits, organisational readiness, and external pressure were considered to be important factors for the adoption of EDI technology in the study of [IBD95]. In [GP03] a study with small and mediums sized businesses identified that the factor of compatibility is highly influencing the adoption of e-commerce technology.

### 1.3 Objectives of this Doctoral Thesis

Standardised electronic contracts are an important building block for compatibility and consequently a basis for cooperation between companies and customers doing electronic commerce. Studies about the adoption of electronic commerce clearly show that among other factors the perceived ease of use, the perceived usefulness, and especially the compatibility of e-commerce systems are the main reasons for the adoption of e-commerce systems (see Section 1.2). Therefore, electronic contracts as an elementary constituent of electronic commerce need to be easily exchangeable and
processable to provide compatibility for e-commerce systems. Thus, electronic contracts have the potential to acquire the same acceptance, validity and trustworthiness as contracts in the paper world, and to quicken electronic commerce. To achieve this goal technically, a number of issues have to be solved: standardised syntax, semantics, and processing approach. Electronic contracts must have standardised syntax and semantics to be meaningful, machine readable, human and machine interpretable and revisable. Standardised syntax and semantics provide a language that, in turn, allows for exchanging contract information. Additionally, a standardised way of 'using' electronic contracts in software services is required. Here, software services are running programs that process electronic contracts such as access control services or accounting software.

- **Standardised Representation (Syntax) of Electronic Contracts.** To make contracts easily exchangeable, first of all, a standardised representation of electronic contracts is needed. One alternative is to linearise the contract content with the help of the eXtensible Markup Language (XML) [BPSMM00]. XML provides a framework to define the syntax of electronic documents, i.e. the structure and the allowed character set that may occur in documents. The structure and the allowed character set of an electronic contract is then defined in an XML schema [TBMM01, BM01] or XML Document Type Definition (DTD) [BPSMM00]. The nature of XML-based documents provides machine readability. In fact, the machine readability comes with XML parsers that understand the XML schema or DTD and accordingly read XML documents. Today, a large number of commercial and non-commercial XML parsers as well as XML document creators are available.

- **Standardised Semantics of Electronic Contracts.** To be human and machine interpretable electronic contracts require clear semantics. Contract semantics are defined, e.g. in the specifications of rights expression languages (see Chapter 3). Rights expression languages are XML-based languages capable of expressing rights of parties over assets. An instance of a rights expression language is a rights expression. Depending on their content, rights expressions can represent different semantic constructs, e.g. licenses, digital tickets, or contracts. Being machine readable simply means that a parser is able to extract the XML-tag names and their values from electronic contracts. Machine interpretable denotes a semantic analysis of the tags and values of the electronic contract. For example, the XML parser reads an XML–
tag with the name *party* and the value *Department of Information Systems* at a certain location in the XML contract document. The parser is not able to determine whether this party is the consumer, the provider, or simply a beneficiary. To assign the correct meaning to this information an interpreter that is familiar with the specification of the respective rights expression language is required. A language specification, in this context, is a text document or formal semantics that defines the semantics for the elements in a specific XML-schema or DTD. As an alternative to XML, the resource description framework (RDF) [LS99, BG00] could be used to define contract semantics. In contrast to XML, RDF is independent of a specific linearisation technique.

- *Standardised Processing of Electronic Contracts.* Clear syntax and semantics, respectively machine readability and interpretability are prerequisites for processing electronic contracts. Partly the pragmatics, or more exactly the processing task of electronic contracts has to be standardised as well, thus ensuring a common way of *using* electronic contracts in software services. Examples for processing electronic contracts are:

  - *Enforcing Electronic Contracts.* Enforcing electronic contracts is one way of *processing* them. Enforcing is the act of implementing access rights as stated in electronic contracts. Electronic contracts are technically enforceable if: means for processing are provided, the contract comprises all required information, and a 'secure' enforcement software service (e.g. an access control service) is available.

  - *Human Readability of Electronic Contracts.* To be human readable and additionally human revisable the contract information has to be represented in a sensible layout, without showing the XML-typical tags or tree structure. To provide human readability, a software service has to be available that arranges the contract information in a sensible layout.

In the two above examples and most likely in all other contract usages it is important that two dislocated, independent software services have the same effect (or result) when processing an identical electronic contract.

In addition to the above mentioned technical challenges, the handling of electronic contracts additionally has legal, managerial, and security chal-
lenges. For example, it is important to decide whether a contract is legally and technically valid or not, or to uniquely identify contract parties and objects. Besides, it is crucial to know which contract content is mandatory for a specific software service (such as access control service or accounting services) and if, or to what extent the contract content is electronically enforceable.

This work aims at developing methods\(^3\) and tools for exchanging and processing XML-based rights expressions (in particular electronic contracts) in consideration of legal, managerial, and security issues.

The methods and tools (see Section 1.4) aim at reaching the goal, i.e. compatibility via standardised representation, semantics, and processing, and thus address the drawbacks mentioned in the introduction. We are not aware of any methods and tools that are currently available for exchanging and processing of electronic contracts (generally speaking: rights expressions). The methods to be developed need to be of generic nature and independent of a specific technology (e.g. the programming language or the used rights expression language). The tools should be available at least as prototype implementations that are open and extensible and prove the correctness and usability of the introduced methods.

More precisely, my work is focused on designing and implementing a rights expression exchange framework that facilitates the encoding, transmission, and decoding of rights expressions for subsequent processing in software services. With regard to standardisation, the rights expressions shall be formulated in a rights expression language (see Chapter 3). The components require a well defined interface to assure its (re)use in various environments and to ease its integration into existing systems. The implementation shall be coded in an appropriate programming language, reuse existing technology, and consider relevant standards. The deployment of the resulting software components shall be demonstrated in a concrete use case.

Standardisation of processes and interfaces can be used to achieve compatibility [KS94, FS92]. According to studies mentioned in Section 1.2,

\(^3\)A method can be understood as a procedure or concept that is comprising steps to reach a certain goal.
compatibility is a driving factor for the adoption of e-commerce systems. Therefore, I conclude that this thesis has the potential to leverage the adoption of e-commerce technology. E-commerce platforms that facilitate the distribution of digital content via standardised, electronically processable rights expressions additionally have potential to reduce distribution costs and thus can have strategic value [Rig03]. However, these platforms should have in mind to find the right balance (described in [Les01]) between copyright protection and freely available digital content.

1.4 Classification into Research Theory

Firstly, this section defines the term 'Wirtschaftsinformatik' and proposes its translation into English. Then the general classification of the discipline 'Wirtschaftsinformatik' into existing sciences is sketched. Sciences can be classified depending on their research objects, their research goals and their research methods. These three criteria will be used to classify the discipline 'Wirtschaftsinformatik' in general and the work at hand in particular.

This thesis is handed in to acquire the doctoral grade in the field of 'Wirtschaftsinformatik'. 'Wirtschaftsinformatik' is a German term that has no common translation into English. It is sometimes referred to as "Business Information Systems (BIS) Science", "Management Information Systems" (MIS), "Business Informatics", or simply "Information Systems". There is an ongoing debate in the German speaking countries about an appropriate English term. In a panel discussion of the German professors Buhl, Mertens, Koenig, and Krcmar it was stated that the German translation for Information Systems is 'Wirtschaftsinformatik' [BKKM97]. Despite this definition, in this thesis the term business information systems (short: BIS) will be used as the translation of 'Wirtschaftsinformatik', representing the field of information systems that has its focal point on business issues and often applies constructive research methods (see Section 1.4). However, a common agreement exists that 'Wirtschaftsinformatik' has an interdisciplinary orientation between the fields of economics, business administration, and computer science [BKKM97, KHvP95, Fra99].

In general, science is divided into formal science and informal science. In formal sciences, such as mathematics and logic, formal languages are developed that do not have a relation to real objects. Informal sciences
deal with the *description*, *explanation*, and *design* of empiric objects. Informal sciences can be divided into fundamental science and applied science. Whereas fundamental sciences have the goal to *describe* and *explain* empiric objects, applied sciences have the goal to investigate the *design* of sociotechnical systems.

As mentioned above, BIS combines the fields of economics, business administration, and computer science. Computer science is an applied science, whereas economics and business administration can be both, fundamental science and applied science. Therefore, BIS is classified as an informal science, comprising both fundamental and applied sciences. Because of the interdisciplinary orientation between computer science, economics, and business science and the relatively young history, business information systems is lacking a common vision about research object and goal. This difficulty has been mentioned and criticised by various researchers [KHvP95, BKKM97, Fra99, MH02]. In the subsequent paragraphs visions from different researchers about research object and goal of BIS are introduced with the ambition to give a general overview of this matter.

**Research goals of business information systems**

In 1993, the German research commission of information systems defined the research goals of BIS as follows:

> The objective of business information systems is to gain *theories*, *methods*, *tools* and *reviewable knowledge* about/to information- and communication systems and to add methods and tools of business information systems that customise the sociotechnical knowledge and composition subject of scientific studies, to the "scientific case of methods and tools".[Wis94]

**Research objects of business information systems**

Two years later, in a panel discussion [KKK+95] the German professors H. Krcmar, W. König, K. Kurbel, D. B. Pressmar, A–W. Scheer, and W. Stucky named the following issues as current research objects of BIS:

- *Distributed information systems in business and management*. W. König: "The long term research goal in this field is to develop a normative co–ordination scheme for interacting actors. We aim to better
integrate methods, tools, and applications, thus connecting human actors and machines more economically . . .”

- **Empirical research on information systems in Germany.** H. Krcmar: “This research comprises survey methods, case studies, ethnographic studies, and laboratory studies in the field of BIS”.

- **Parallel Processing and business applications.** D.B. Pressmar: ”The application of evolving technologies to optimisation problems in production planning, such as scheduling and lot sizing. Computational power is also needed when building neural networks to problems of pattern recognition such as forecasting or diagnosis in quality management and controlling”.

- **Research on petri nets.** K. Kurbel: “This research field is especially focused on process modelling. Petri Nets are proposed as formal description language for business processes”.

- **The influence of [BIS] research on industry.** A.–W. Scheer: “The BIS research is strongly dedicated to the development of prototypes. The ideas behind the prototypes should be included into commercial software products and improve applied information systems”.

In the same year, the findings of an investigation, that tried to identify the essential research objects and theories of BIS with the help of the Delphi and AHP (Analytic Hierarch Process) method were published [KHvP95]. According to this investigation the four most important research objects in BIS are:

1. **Science with a strong relation to organisation theory.** This approach tries to describe and optimise the structure and process flow of sociotechnical systems.

2. **Functional business administration.** This discipline is investigating particularly the role of data processing and information processing in companies.

3. **Information science.** Information science aims at exploring the economy of the power factor ”information” and its purposive allocation.

4. **Innovation science.** This discipline defines requirements for new information and communication techniques, and implements the resulting products and processes in companies.
Research goals of this thesis:
The research goal of this work is to develop methods, tools, and reviewable knowledge in the field of BIS, namely:

- **methods**, such as, the mapping of electronic contracts (respectively rights expressions) to a generic contract schema (see Section 4.6), or the process for composing tailored contracts (see Section 4.5),

- **tools**, e.g. the prototype implementation of a software tool that facilitates the generation of rights expressions, or the prototype implementation of a software tool that facilitates the interpretation of rights expressions, or (see Chapter 6), and

- **reviewable knowledge** e.g. about typical functions in DRM systems, the core components and the application-specific components of electronic contracts, characteristics of rights expressions languages, the constituents of a rights expression exchange framework, etc.

Thus this thesis meets the requirements in accordance with the research goal of the German research commission of information systems [Wis94].

Research objects of this thesis:
In general, the research object of this thesis is to provide technology to facilitate economic concepts. The methods and tools developed in this work shall provide technical means to support new business models for digital goods, to support technical means to meet the legal requirements of electronic contracts (e.g. providing digital signature information), as well as to provide new functionality to DRM systems in general, such as interoperability. Therefore, the thesis at hand models the processes of generating, wrapping, transmitting, unwrapping, and interpreting electronic contracts in a generalised way. In particular it addresses the processing of rights expressions in subsequent software services. As rights expression languages play a substantial role in this field, an empiric survey on rights expression languages is necessary. The work shall present the design and implementation of software tools that are capable of generating, wrapping, unwrapping, interpreting, and processing rights expressions. The work shall include a prototype implementation of such a general design and integrate the prototypes into different software environments. The overall focus of this work is to better integrate human actors and machines by providing means for
the comfortable handling of electronic contracts. This thesis addresses the essential research objects (integration of applications, process modelling, surveys, and prototype development) of BIS in accordance with [KKK+95].

**Research methods of business information systems**

In [LHM95] it is stated that: "... [BIS] applies methods and tools out of formal, informal and engineering science and develops them. The sociotechnical cognition subject of [BIS] demands that not only questions of technical efficiency but also questions of economical and social utilisation (including the acceptance of different social groups) are considered within the choice and combination of the used methods and tools."

In 1997 H.U. Buhl et al. three dominant methodological orientations in business information systems are named [BKKM97]:

1. **Engineering.** This approach aims at developing and testing software prototypes, including the design and application of formal modelling methods.

2. **System integration.** This approach focuses on organisational aspects of introducing and using information systems.

3. **General Models.** This approach aims at the development and analysis of formal models in order to support optimisation and decision making in general.

Most researchers feel committed to one of these three approaches exclusively. The combination of the various disciplines in BIS result in different methodological research orientations, depending on the weight of each discipline in the research work.

*Empirical* methods as well as *constructive* methods are the basic research methods in the field of BIS [Hol99, KHvP95]. The BIS incorporates the anglo-american MIS research as well as application oriented aspects of computer science; thus, compared to MIS research its methodologies are more constructive [ASBA99].

- Empirical research follows the process of problem analysis, i.e. developing a theoretical model and testing the model, data analysis, and interpretation. The interpretation of the results of such an analysis produces new knowledge.
Constructive methods follow the idea that new knowledge is gained by constructing new ideas or concepts based upon the researcher's knowledge. Accordingly, when deploying constructive methods, the researcher does not try to verify predefined theories.

The discussion in the previous paragraphs have illustrated the disaccord on the objects of research in BIS. This disaccord causes some researchers to question if BIS actually needs its own research methods and theories [KHvP95, LHM95]. In practice, researchers avail themselves of methodologies from the related "mother" sciences business science and computer science.

Research methods applied in this thesis

In this thesis empirical methods as well as constructive research methods are applied. In general, this thesis follows the process of problem analysis, comprising the phases problem analysis, development of theoretical model, testing the model, and analysis and interpretation. The empiric objects in this process are electronic contracts, or, more generally, electronic (or digital) rights expressions:

- **Problem analysis.** Rights expression languages are a means to express usage and access rights of parties over (digital) assets. Such languages support the trading of electronic goods via the Internet. There are different initiatives that are developing language syntax and vocabulary for rights expression languages, but no general concept has been discussed or designed that describes the exchange and processing of rights expressions. The problem and research question of this work is: "What does a framework design that is capable of exchanging and processing rights expressions to support DRM system interoperability look like?"

- **Development of a theoretical model.** This phase comprises the design development of a framework that is capable of exchanging and processing rights expressions (e.g. in the form of electronic contracts).

The theoretical model for the exchange of rights expressions signifies that the communication model [Sch71] of Schramm illustrated in Figure 5.1 (a further development of Shannon's basic communication model [Sha48]) can be adapted to the communication via rights
expressions. The resulting rights expression communication model is the basis for the rights expression exchange framework, consisting of the four tools: rights expression generator, - wrapper, - unwrapper, and - interpreter.

The theoretical model for rights expression processing is the generic contract schema (see Section 4.6). It describes a generic data model that serves as a basis for rights expression processing and facilitates an approach of the semantically unambiguous representation and processing of electronic contracts.

- Testing the model (Implementation). The implementation of a prototype is a means to test the previously developed framework design. The framework implementation naturally incorporates the theoretical model of rights expression processing (i.e. the generic contract schema).

- Analysis and Interpretation. The integration into various system environments allows an analysis of the framework design and its usability. A concrete application shows the usability for a certain domain (e.g. processing contract in the educational domain). The interpretation of the analysis' results are part of the findings of the work at hand.

Constructive methods have been applied during the implementation phase. For example, object oriented concepts have been used to structure and develop the tool for exchanging and processing rights expressions. The process definition for scenario-specific contract composition (see Section 4.5.3) has been developed in a constructive manner.

1.5 Structure of this Doctoral Thesis

The work at hand has the following further structure:

- Chapter 2 is an introduction to the area of digital rights management systems. Firstly, the chapter deals with the general commercialisation of digital goods. Consequently, it addresses characteristics, dimensions, and business models for digital goods. The chapter discusses various definitions of the term Digital Rights Management (DRM) and introduces the perspectives of DRM. The basic functions of a DRM system are defined, namely: Content Provision, Content Safekeeping, Offer Placement, Content Preparation, Content Distribution,
Booking, Payment, Authorisation, and Content Consumption. A subsequent section describes a sample system comprising all basic DRM functions that are grouped into typical system components. The information flow through such a sample system, which is basically the interaction between modules that implement a certain function and components, is described in detail. Finally, the role that rights expression languages play in DRM systems is explained.

- Chapter 3 gives an introduction to the field of rights expression languages. The chapter addresses the requirements and characteristics of rights expression languages. It introduces relevant existing rights expression languages, gives some practical examples, and shows their deployment in current non-commercial and commercial software products.

- Chapter 4 deals with relevant aspects of handling electronic contracts. Electronic contracts can be expressed in rights expression languages. Thus, the contracts have a standardised representation that facilitates the exchange of contracts between interoperating platforms. The chapter introduces a contract's life cycle and discusses typical technical states. It further presents means for rights execution, i.e. the technical fulfillment of contracts. The contract content is analysed in detail; core elements as well as application-specific elements of contracts are identified. The chapter discusses potential exploitation (or usage scenarios) of electronic contracts and describes the process of creating tailored electronic contracts. The generic contract schema (CoSa) is introduced; the generic CoSa is a concept for a (rights expression) language independent representation of electronic contracts. The chapter finally addresses the enforceability of electronic contracts, management issues when handling electronic contracts, and relevant related work.

- In Chapter 5 a general communication model facilitating the exchange of rights expressions is introduced. From the model a software framework, namely the rights expression exchange framework, is derived. This framework consists of the software components rights expression generator, -wrapper, -unwrapper, and interpreter. Additional sections describe the detailed functionality of all framework components and the technical requirements independent of a specific technological approach.
• Chapter 6 shows one implementation of the rights expression exchange framework that is naturally compliant with the general design described in Chapter 5. The components are capable of generating, wrapping, unwrapping, and interpreting rights expressions of the XML-based open digital rights language (ODRL)\textsuperscript{4} [Ian02b] and are open for the support of any other current or future rights expression language. The implementation is coded in XOTcl\textsuperscript{5} and reuses various software tools, such as the tDOM parser\textsuperscript{6} for the handling of XML documents in general or the MySQL\textsuperscript{7} data base server. The chapter gives detailed information about the tools class hierarchies and interfaces and presents examples for the tools' usage.

• Chapter 7 exemplifies an application of the rights expression exchange framework components. It describes the successful integration of the generator – and wrapper component in ActiWeb, a class library that is supporting extended web server functionality, and the deployment of the unwrapper – and interpreter component with an access control service.

• The conclusion gives a summarisation of this work. It highlights the developed findings in the field of exchanging and processing rights expressions. Additionally, the chapter addresses future work in this field that can be based on the work at hand.

\textsuperscript{4}See http://www.odrl.net/
\textsuperscript{5}See: http://www.xotcl.org/
\textsuperscript{6}See: http://www.tdom.org/
\textsuperscript{7}See: http://www.mysql.org/