Toward a Conceptual Framework for Digital Contract Composition and Fulfillment *

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Abstract

This paper deals with current (conceptual) issues in the field of contract management. We describe a basic contract life cycle with four phases: offer placement, offer confirmation (conclusion of the contract), fulfillment of duties (consumption of rights), and contract archiving. In our investigation of contract content, we identify core contract objects, usage-specific extension objects and their relationships. On the basis of various usage scenarios for digital contracts, we proceed to introduce an approach for scenario-specific contract composition (Phases 1 and 2 of the contract life cycle). Addressing phase 3 of the contract life cycle (fulfillment of digital contracts), we distinguish digital contracts from electronic tickets, and finally envisage the consumption of usage rights by means of electronic tickets.

1 Introduction

As soon as digital goods are exchanged between different parties, the need arises for digital contracts. The rapidly growing interest in digital goods of various kinds (e.g. music files, access to digital libraries, or e-learning content) is thus accompanied by increasing demand for digital contracts. To be precise, on evolving online brokerage platforms 'usage rights' for digital goods are exchanged rather than the goods themselves, but in this paper we simply use the term 'digital goods.' Digital contracts are intended to specify terms and conditions and to enable the automated processing of online business transactions to a certain extent.

For the purposes of this paper, we will presuppose that a digital contract is a document formulated in a digital rights language. Today's most popular digital rights languages use XML (see, e.g. [4, 13]) as a representation and interchange format. At modeling level, a digital contract can be seen as a composition of different contract objects with various attributes. In other words, a digital contract aggregates a number of interrelated objects.

Contract objects can be subdivided into *core objects* with *core attributes*, which have to be included in any kind of digital contract, and additional *domain-specific objects* and/or *domain-specific attributes*, which may be added according to the intended use of a specific contract. This means that a digital contract can be composed more precisely if the *usage scenarios* for a particular contract are known in advance. We thus aim to provide a conceptual framework which enables the composition of digital contracts tailored to the requirements of specific usage scenarios. Moreover, we propose a first step toward a conceptual framework for the composition and fulfillment of digital contracts.

The remainder of the paper is structured as follows: In Section 2 we give an overview of the contract life cycle and describe the basic states and state transitions for digital contracts. In Section 3, we proceed

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to identify core contract objects, with each object type covering a specific kind of information (such as the personal data of the different contracting parties, or the rights and duties defined by a contract). Subsequently, we mention various usage scenarios for the application of digital contracts (e.g. access control or customer relationship management). In Section 4, we then propose a basic process for the tailored composition of digital contracts. We then deal with the subject of contract execution/fulfillment and rights consumption in Section 5, where we go into particular detail on the relationship between digital contracts and digital tickets. Section 6 concludes the paper and gives an overview of future activities.

2 The Contract Life Cycle: An Overview

Fur the purposes of this paper, we define a digital contract dealing with electronic goods or services as follows:

> A digital/electronic contract is an agreement of at least one (an example of a unilateral contract would be a last will and testament), but typically two or more parties, on the exchange of rights to digital goods or services.

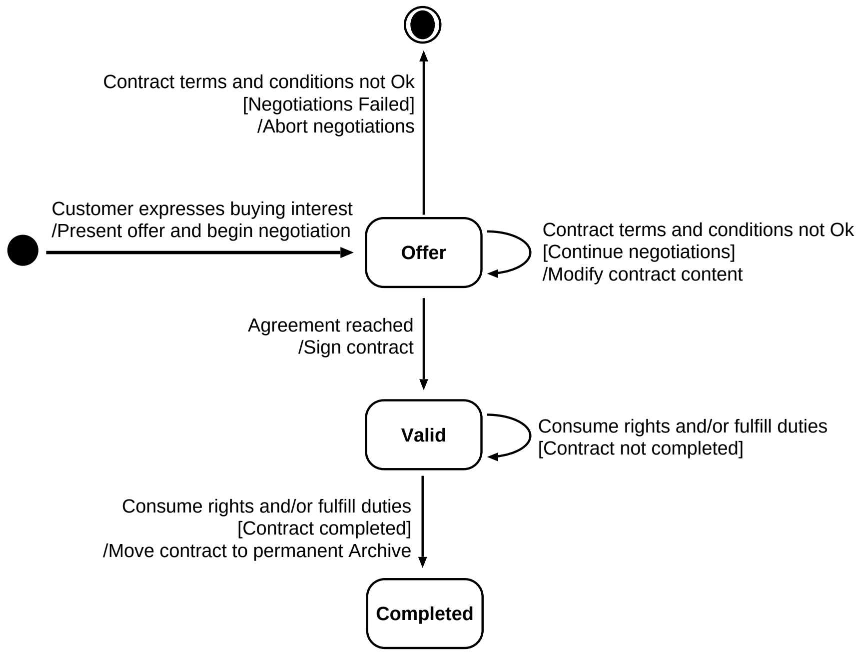

Figure 1: Basic states and state transitions of digital contracts

Figure 1 depicts a state chart diagram with the basic states and state transitions of digital contracts. Once a consumer expresses interest in buying certain digital goods or services, the owner of the corresponding content presents an *offer* and thereby begins the negotiations. In general, the consumer may accept the offer, demand modifications to the offer, or reject the offer. If an agreement is reached, both parties (consumer and content owner) sign the contract, which in turn becomes *valid*. Subsequently, both parties can consume the rights and/or have to fulfill the duties specified in the contract. Once all rights are consumed and all duties fulfilled, the contract is completed and then moved to a permanent archive.

Figure 2 shows a simple contract life cycle from a legal standpoint, corresponding to the state chart diagram in Figure 1. The contract life cycle describes four different phases undergone by digital contracts:

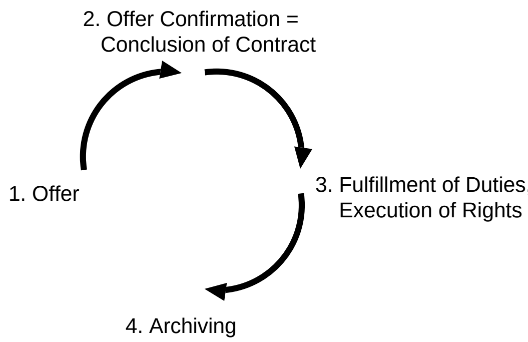

Figure 2: A simple contract life cycle with four phases

1. *Offer Placement*. The content owner (rights holder) *offers* his/her goods to the consumer on certain terms and conditions. These terms and conditions describe the rights and duties of the contracting parties (generally the consumer and the content owner). Each offer is signed by the content owner.

2. *Offer Confirmation / Conclusion of Contract*. At this stage, the consumer confirms the offer made by the content provider. The consumer does so by signing the offer and thereby accepting the terms and conditions offered. Note that a *negotiation phase* often precedes contract conclusion. In other words, a contract can only be concluded if the contracting parties reach an agreement on the relevant terms and conditions. In the negotiation phase, therefore, it is also possible to formulate a new offer for the contracting parties to agree on; such a new offer may include significant modifications to the contract's original terms and conditions (cf. Figure 1). In order to be legally *valid*, a contract has to be signed by all contracting parties.

3. *Fulfillment of Duties/Consumption of Rights*. In this stage, the "execution" of the contract takes place, i.e. the contract parties exercise their rights and fulfill their duties under the corresponding contract. The chronological sequence of these actions can be specified in the contract (e.g. payment in advance). Once all rights have been exercised and all duties have been fulfilled, the contract is *completed*.

4. *Archiving of Contract*. After completion, each contract is saved in a permanent archive. However, the statutory period for which a particular contract has to remain archived depends on the type of contract and on local law (e.g. contract of sale, last will and testament, etc.).

Note that in general the duties of the provider/owner are the rights of the consumer, and vice versa. Therefore, instead of defining rights and duties separately, digital contracts can be formulated with rights expressions only. For example, the right of a customer to attend a concert gives the concert promoter the right to receive the corresponding entrance fee from that particular customer.

3 Contract Content and Usage

In this paper, we suggest dividing digital contracts into a number of interrelated contract objects. Each contract object comprises several attributes; for example, the Person object includes attributes which describe the contracting parties (e.g. name, address, etc.). Moreover, digital contracts can be applied in various usage scenarios, each of which requires a number of additional scenario-specific (or domain-specific) contract objects and/or attributes.

In Section 3.1, we introduce the core objects of digital contracts, followed by a number of usage scenarios for digital contracts in Section 3.2 (e.g. access control, customer relationship management, or intellectual property rights protection). We then identify a number of scenario-specific contract objects and attributes which are required to cover the respective usage scenario. Our approach spans a relatively broad range of possible uses for digital contracts. However, it does not claim to be ”complete” and could be extended at reasonable expense. In Section 4, we proceed to introduce a process for the tailored composition of digital contracts, considering which attributes need to be included in a certain contract with respect to its intended use (i.e. the usage scenarios a contract is to be applied in).

3.1 Core Contract Objects

In this section, we propose three types of contract objects which can be seen as core objects of digital contracts. The definition of these core objects was influenced by earlier information models [12], our experience with current rights expression languages which often apply similar approaches [4, 13]), and our investigation of projects in which digital contracts are used (e.g. the COLIS project [1]).

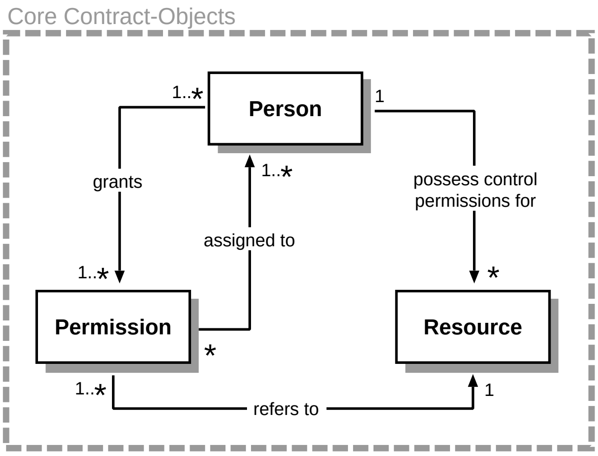

Figure 3: The core objects of digital contracts

The core object types needed for the composition of digital contracts are: Person, Resource, and Permission (see Figure 3). Specific persons (“rights holders”) possess control permission for specific resources. A person in possession of such control permissions is thus authorized to grant usage permissions to other persons (“beneficiaries”). Each permission refers to one particular resource or a specific type of resource, and one or more permissions may exist for each resource. Each of the contract objects shown in Figure 3 comprises a number of attributes, such as:

- The *Person* type represents contracting parties and other related persons such as additional beneficiaries or contact persons. Persons are identified by a mandatory and unique *user id*. Other personal data attributes which might be relevant in the processing of contracts are: *name, position, age, credit standing, profession, etc.*

- The *Resource* type represents the objects of the agreement, that is, the digital goods or services themselves. Resources are likewise identified by a mandatory and unique *resource id*, as well as optional metadata. Possible identifiers for digital goods might include a uniform resource identifier (URI) [3] or a digital object identifier (DOI) [2]. The optional metadata attributes may supply details on the resource, for example *book title, author, isbn number, description, size, file format, author’s remarks, etc.*.

- The *Permission* type represents the concrete usage rights granted/assigned to the consumer as a result of the conclusion of the contract. Permissions express usage rights (e.g. play music file, print document, etc.) and may also comprise attributes describing (informal) copyright information or (informal) derivative work rights. Permissions can be enforced either legally or electronically (by a software service). Typical data in this attribute category includes rights such as *print, play, copy, modify*; constraints such as *count, date, role, range, purpose*; and preconditions such as *payment, accept, register*. In connection with digital contracts, a special kind of permission attribute is the *exchange value*. In general, the exchange value is the price of the respective resource (generally a digital product or service). However, as mentioned above, consumers purchase usage permissions, not the digital goods themselves. The goods might also be bartered or paid for with artificial credits. On a technical level, attributes in this category are most often mapped to permissions and/or preconditions which have to be fulfilled prior to granting a certain permission to a specific contracting party. Typical attributes describing the exchange value include *payment method, price, and currency*.

Rights expression languages (RELs) aim to provide a syntax and semantics for the (semi-)formal representation of digital contracts. These languages are often based on XML and therefore enable the automated processing of digital contracts. Moreover, RELs make it possible to reuse domain-specific description languages such as the Learning Object Metadata (LOM) standard [14] or Dublin Core [5], for example. Rights expression languages used for contract representation enable specification of the core contract objects described above (e.g. see [4, 13]) and support the construction of a namespace for expressing contracts.

3.2 Usage Scenarios for Digital Contracts

In this section, we introduce several usage scenarios for digital contracts. As mentioned above, all information in digital contracts and their respective uses should be clearly defined in order to facilitate the automated processing of contract information. In the paragraphs below, we provide a sample overview of usage scenarios in which digital contracts can be applied. This selection of usage scenarios is based on our experience in the field of digital contracts, an additional analysis of the literature on rights expression languages [4, 13], research papers [16, 9] as well as projects dealing with the management of electronic contracts (e.g. the COLIS project [1]).

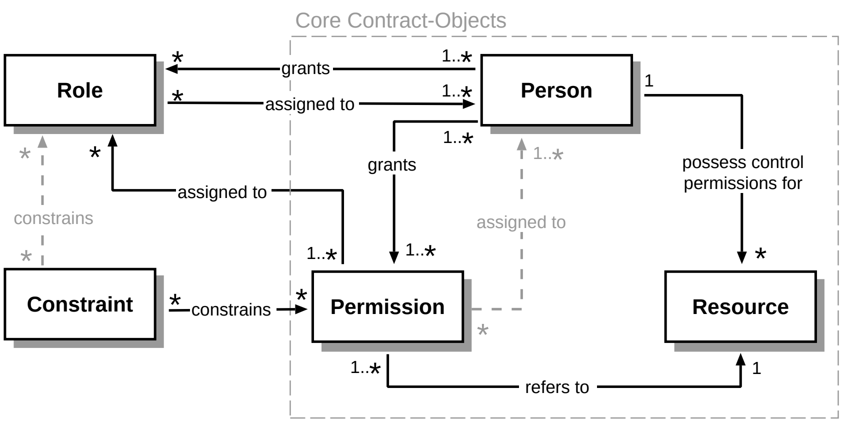

Figure 4: Extension through usage-specific contract objects - an example

- *Access Control*. Contracts contain information on permissions granted to one or more contracting parties for digital goods or services. The information to be included in a digital contract varies depending on the access control model to be applied. For example, in the case of role-based access control [6, 18], the Role and Constraint object types may be added to a digital contract (see Figure 4). Roles add a level of indirectness between permissions and users/persons, in that permissions are assigned to roles and roles are assigned to persons. Roles can be arranged in role-hierarchies where more powerful roles (senior-roles) inherit permissions (and constraints) from subordinate roles (junior-roles). A role-hierarchy is a directed acyclic graph. Thus a person indirectly receives the permissions assigned to their role(s). Permissions can also be associated with *constraints*. One specific type of constraint is a precondition, that is, a premise which has to be fulfilled before a right can be granted/assigned to a specific person. Other types of constraints might restrict permissions, for example to a certain time interval, or to a specific user or device. For instance, prepayment might be necessary in order to receive the right to play an audio file (assignment constraint), and once the fee is paid this particular right might be exercised a limited number of times (authorization constraint).

- *Customer Relationship Management (CRM)*. The overall body of contracts concluded can represent a valuable data pool for marketing activities. Information on what customers are purchasing, that is, which goods or what type of services customers usually demand, can form an information basis for marketing activities such as one-to-one marketing or personalized marketing within the framework of Customer Relationship Management. For example, personalized goods or services can be offered to the respective customer on the basis of his/her recorded contract history.

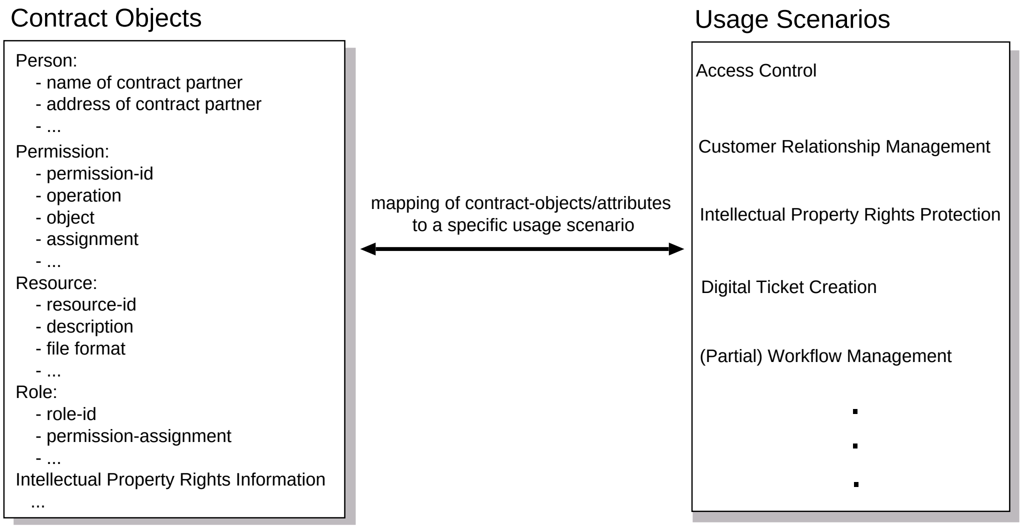

Figure 5: Required mapping of usage scenarios to contract objects

- *Intellectual Property Rights (IPRs) Protection*. From a legal perspective, content owners market their IPRs to customers. Digital contracts provide a means for the content owner to specify the extent to which the content may be used. As the IPRs specified in digital contracts are enforced (semi-)automatically, the IPRs of content owners are protected. Therefore, on a technical level this can be seen as a special case of access control.

- *Workflow Control*. To a certain degree, digital contracts can be used to specify workflow process information, which can be used to control certain task sequences in an information system. For example, let us assume a contract which stipulates that a right is granted once a certain amount has been paid to the content provider. This information can be used by the workflow process in such a way that the incoming payment event initiates the assignment of the specified right to the respective user(s).

- *Exchange of Contract/Rights Information*. In recent years, a number of marketplaces for digital goods have evolved. In order to provide customers and retailers with a uniform environment, it is sensible to aim for an interoperable exchange format. One important part of this interoperability can be attained by exchanging rights information on the basis of a standardized REL.

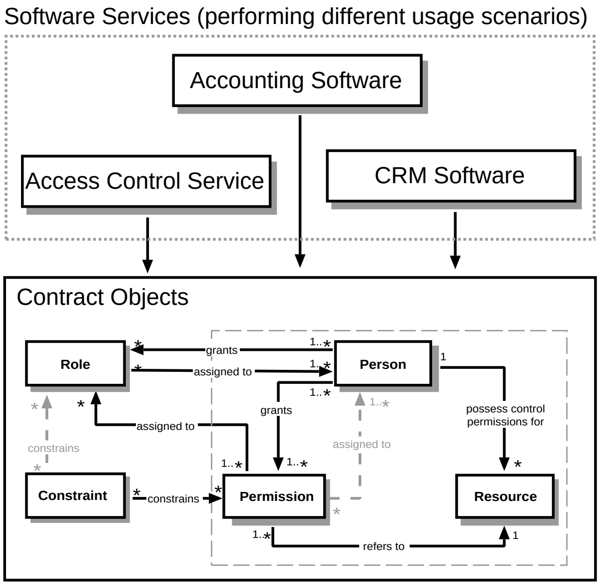

Figure 6: Various usage scenarios for digital contracts

Each of the above-mentioned usage scenarios requires a certain number and type of attributes in order to process contract data properly. Figure 5 maps various contract objects and their respective attributes to corresponding usage scenarios. Each usage scenario may require several attributes from different contract objects, and contract objects (and attributes) might be used in one or more usage scenarios. As an example, Figure 6 shows different software services accessing digital contracts in order to fulfill specific usage scenarios based on the contract.

4 Scenario-specific Contract Composition

In order to ensure that digital contracts contain sufficient information to satisfy the requirements of specific usage scenarios, the contracts need to be tailored with regard to their intended uses. Below we introduce a basic process for the tailored composition of digital contracts, assuming that the contract objects and attributes required by a specific usage scenario are known and predefined.

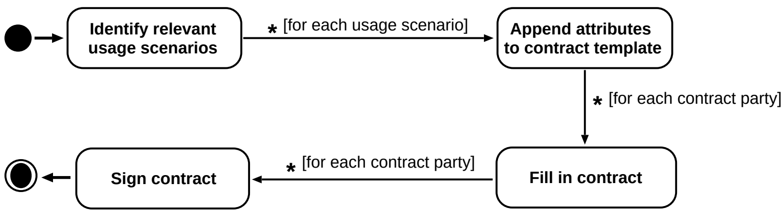

Figure 7: Composing tailored digital contracts

Figure 7 depicts a process for composing tailored digital contracts, and the various activities shown are described below.

- *Identify relevant usage scenarios*: In this activity, we use the list of different usage scenarios (see Section 3.2) to specify the intended use of the contract under consideration. In other words, we define the estimated use of this particular contract.

- *Append attributes to contract template*: Each usage scenario is related to a number of different attributes. Thus the relevant contract objects can be derived in a straightforward manner from the usage scenarios defined in the previous step. Based on this information, we can generate a contract template consisting of the exact number and types of attributes needed for this particular contract.

- *Fill in contract*: Here we fill in the different attributes with actual values, that is, the terms and conditions to be included in the contract. Note that at this point the contract is still in the negotiation or offer state (see Section 2). All contracting parties have to agree on the actual attribute values before the contract can be signed. If necessary, the contract is modified until an agreement is reached (see also Figure 1).

- *Sign contract*: In the final step, the contract needs to be signed by each contracting party in order to be considered valid. At this point, the contract reaches the 'Conclusion' stage in its life cycle. The next stage in the contract life cycle - the exercising of rights - will be addressed in the next section.

The proposed process of application-specific contract composition should be implemented by the license phrazing component of a contract and rights management framework such as the one introduced in [11]. The process facilitates a contract's enforceability. Permissions defined in a digital contract are electronically enforceable if the contract can be processed automatically, and if processing conforms with the contracting parties' intentions [10]. For example, a contract consisting of the contract objects shown in Figure 4 has the potential to be fully electronically enforceable in terms of access control services.

However, if a contract is not designed as proposed above, it can still be a valuable source of information for specific applications. In such cases, a 'contrary' approach to processing contracts can be applied, after which data mining procedures can be applied to digital contracts, for instance. In such a case, the above-mentioned usage scenarios will be less likely to find all the required information in the contract. Accordingly, the enforceablity of such contracts is comparatively low.

Note that the question of who decides on contract usage and consequently on contract objects (contract negotiation, see Section 2) might be an interesting issue for future work. This matter also requires a discussion of organizational and privacy issues in contract composition, as the contract content should be agreed upon by all contracting parties. For example, on the one hand contracting parties will demand that their personal information be handled as confidential, while on the other hand the marketing department will be interested in personal information for CRM purposes.

5 Execution of Contracts / Rights Consumption

Rights are exercised in the "Fulfillment of Duties / Consumption of Rights" stage of the contract life cycle. For the purpose of explaining the "Execution of Rights" sub-process in detail, we will introduce the term *electronic tickets* and distinguish them from digital contracts.

5.1 Contracts and Tickets

There are a number of different approaches to enabling the consumption of rights granted in a digital contract. One interesting approach is described in the work of Fujimura et al. [7] and Stefik [19], who define the term "digital/electronic tickets." In this section, we will identify the similarities and differences between digital contracts and digital tickets, provide a definition of digital tickets and subsequently distinguish them from digital contracts.

In the definition of electronic contracts in Sections 2 and 3.1, these contracts comprise information about the contracting parties, the digital resources (the object of the agreement), and the specified permissions for digital goods or services. For the purposes of this paper, we define digital/electronic tickets as follows:

> A digital/electronic ticket is the option to consume a permission for digital goods or services.

Digital contracts and tickets both contain rights expressions pertaining to digital goods or services. Owning a ticket is, however, different from being party to a digital contract. Among other things, a contract specifies permissions exchanged between the contracting parties, while an electronic ticket describes an excerpt from a contract, specifically one (or more) permission(s) which can be executed. In Section 3.1, we mentioned that both the rights *and* duties arising from a contract can be expressed in the form of permissions. In turn, each permission specified in a contract can be extracted and formulated as a ticket. In one frequently encountered scenario, two parties conclude a digital contract in which one party receives the permission to consume specific digital goods, while the other party receives the permission to collect money for those goods (or for the respective permissions). When executing a contract, permissions can thus be transformed into tickets which may be executed independently of each other.

For example, a rock concert promoter sells two tickets for admission to a person who is planning to see the concert with a friend. The right to attend the concert with a friend (the right of the consumer) as well as the right to receive the concert entrance fee (the right of the concert promoter) can be extracted from the contract and formulated as stand-alone digital tickets. The concert promoter thus owns a ticket that allows him to collect money from the consumer, and in return the consumer has the right to receive two tickets for admission to the concert (cf. Figure 8).

The chronological sequence in which the tickets are executed (or redeemed) can be specified in a digital contract. Concert tickets, for example, have to be paid for in advance in most cases. Once the concert promoter has received the entrance fee, he issues the concert tickets to the consumer, thereby granting the right(s) to attend that particular concert.

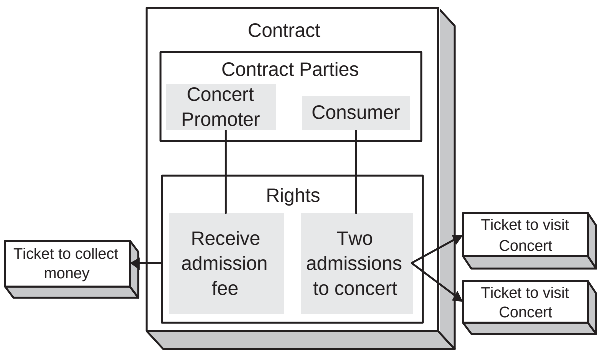

Figure 8: Contracts and tickets - an example

Other authors have referred to digital tickets as a means of payment [17]. However, this does not correspond exactly to the definition given above. From our point of view, tickets are part of the contract life cycle and occur in Phase 3, “Fulfillment of Duties / Consumption of Rights” (cf. Section 2). As mentioned above, some permissions specified in a contract might result in a ticket allowing one of the contracting parties to collect money from another contracting party. In this particular case, the digital ticket can be seen as “a means of payment.” However, the exercising of other types of rights, such as "attending a concert", results in a ticket issued by the concert promoter; in such cases the ticket serves as "a means of gaining admission." Under our definition of tickets, their use as "a means of payment" is one - but not the only - way in which digital tickets can be applied.

5.2 Ticket Characteristics

A digital ticket can be personalized (i.e. bound to a certain individual) or anonymous:

- *Anonymous*. A digital ticket is considered anonymous if only the issuer of the ticket can be identified, while the beneficiary remains anonymous. Since contracting parties can be identified by their digital signatures, an anonymous ticket only has to be signed by the issuer. In other words, a digital ticket must at least include the signature of the ticket issuer so that he can verify the integrity and authenticity of the digital ticket.

- *Personalized*. A digital ticket is personalized if it is signed by the beneficiary (the "consumer") and the issuer. Anonymous tickets are typically used for concerts or bus fares, to name but two examples. In such a scenario, the identity of the person who executes a ticket is generally not important to the issuer. One possible use of personalized tickets is in airline ticketing, as airline companies are required to verify the identity of the passengers on a flight.

In many cases, all ticket information is available in the contract, and it is reasonable to pose the question of *sensible applications of electronic tickets*. Examples might include the following:

- *Privacy*. If, for example, one or more of the contracting parties wants to consume their rights anonymously, a ticket is a means of addressing this issue.

- *Efficiency*. As tickets are excerpts from contracts, they often comprise a smaller amount of data. The actual size of a digital document can be relevant for storage-restricted applications, for example transmitting electronic tickets to chip cards or SIM cards.

- *Specific Ticket Information*. In some cases, consumption-relevant information (for example, the current download location of a digital resource) is not specified in the contract but has to be added to the ticket when issued.

However, the fulfillment of a contract does not have to be regulated by tickets. For instance, it is not sensible to issue tickets for a service that can be consumed without specific limitations. If, for example, a consumer enters into a contract for an online newspaper subscription without a specific time limit, it does not appear sensible to issue an admission ticket for each and every time the newspaper is accessed. In our view, the most sensible use of tickets is to issue a ticket for a single or limited number of usage rights, such as downloading a specific resource or streaming a certain video.

In cases where a contract specifies that goods or services may be accessed a certain number of times, the ticket issuer can use two basic mechanisms to formulate a ticket. He can either issue a certain *number of equal tickets*, or *one ticket* that expires once all rights have been exercised. Depending on the intended use of the ticket and the technology used, both mechanisms can be appropriate. Issuing one ticket for each use may result in a large number of electronic tickets to be stored and managed. On the other hand, changing the number of "remaining uses" in the ticket after each use requires greater administration and security effort at runtime.

One proposal for a formal ticket language is XML Ticket [8]. Every ticket formulated in XML Ticket can theoretically be expressed in a digital rights language, but not vice versa. XML Ticket only provides the syntax and semantics to specify a right (or option) that a ticket issuer grants to a (subsequent) ticket owner. The XML Ticket language is restricted to these two roles (issuer, owner) and provides no means of expressing other relevant information, such as payments methods, etc. Furthermore, the XML Ticket language is not subject to an ongoing improvement process, thus for the time being we propose the formal expression of tickets in a digital rights language as well.

6 Conclusion and Future Work

In this paper, we gave an overview of the life cycle of digital contracts and described the (supporting) activities to be performed in the different phases of this life cycle. In particular, we identified the core objects of digital contracts, as well as additional contract objects and attributes which can be added to a digital contract according to its specific usage scenario. Moreover, we present a process for the tailored composition of digital contracts, and discuss the ways in which digital tickets can be applied in the consumption of rights granted in a digital contract.

As digital contracts can be formulated in special-purpose rights expression languages (see, e.g. [13, 4]), the requirements that apply to different RELs [15] also apply to digital contracts.

As described in Section 5, a contract may specify a right to collect money from another contracting party. Therefore, a ticket derived from a contract which empowers a contracting party to collect money has to meet the requirements of digital cash. Consequently, it will also be necessary to examine the extent to which requirements for electronic cash also apply to electronic contracts which contain e-cash relevant information.

In our future work, we will continue to elaborate on the definition of contract objects and the relationships between these objects, as well as the mapping of contract objects (and their attributes) to specific usage scenarios. We thus aim to map specific usage scenarios to one or more contract objects and attributes. Moreover, we plan to provide tool support for the composition and management of tailored digital contracts (as described in Section 4), and for the semi-automated generation of digital tickets from these contracts.

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