Modeling the Dynamics of Transferable Obligations in Business Procedures

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Abstract

To facilitate electronic commerce in international trade, paper-based documents in trade procedures have to be replaced by electronic messages. This can be viewed as a business process redesign problem. In this paper we present a formal framework for representing so-called Deontic Deep Structure Models (DDSM) for business procedures. These models can be used to support the electronification of such procedures. The framework is based on a combination of deontic logic and action logic. To illustrate its usefulness we show how the formal framework can be applied to analyze some international trade procedures in which obligations are transferred from one agent to another agent

1. Introduction

In order to facilitate electronic commerce, i.e. doing business via electronic networks like Internet or World Wide Web, in international trade, paper-based documents in trade procedures have to be replaced by electronic messages. This can be viewed as a business process redesign problem. The paper-based procedure has to be redesigned for an electronic environment. In this paper we propose a formal framework to support this redesign process. In particular, we argue that deontic logic, i.e. the logic about obligations, permissions and rights, is a useful tool for this procedure redesign.

1.1 Transferable obligations in international trade

In international trade procedures transfer of obligations and rights is a crucial notion. An example of a transfer of rights is the Bill of Lading. The bill of lading is a document that has been used in international sea trade for centuries. This document plays different roles in international trade procedures: proof of shipment, claim document and even collateral for the banks that finance the trade. Therefore, it is complicated to redesign the paper-based bill of lading into an electronic document, and much research has already been done on the electronification of the bill of lading. An example of a typical situation to use a bill of lading is the following. A seller in Rotterdam has to deliver goods to a buyer in Hong Kong. For the transport the seller hires a transport company to transport the goods from Rotterdam to Hong Kong. The big problem in international trade is time and distance. It can take several weeks before the ship arrives in the port of destination in Hong Kong. During this period the buyer has not yet received his goods, and the seller has not yet received payment for the goods. One way to solve this payment delay for the seller is by an agreement, expressed in a letter of credit, that the buyer will pay in advance when the goods are shipped in the port of origin, provided the seller can give sufficient evidence to the buyer that he has indeed shipped the goods. The buyer demands this evidence, because otherwise he runs the risk that he will pre-pay goods that are never shipped. The bill of lading can be used as evidence. When the seller ships the goods in the port of Rotterdam onto the vessel of the transport company, then the transport company will issue a bill of lading which proves that he received goods from the seller. If the seller gives this bill of lading to the buyer, then the buyer will pay for the goods in advance. So, for the seller the bill of lading is a proof of shipment. For the buyer this document is a claim document. The transport company will only give the goods in the port of destination to the agent that presents the proper bill of lading. Hence, by presenting the bill of lading the buyer can exercise his right to obtain the goods he has paid for in advance. What makes it more complicated is that bills of lading are frequently sold to other agents. The buyer can sell the bill of lading to other agents. For example, in the oil trade it happens quite frequently that a shipment of oil

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is traded several times during the transport. Each time the bill of lading is transferred from the old owner to the new owner the right to claim the oil is also transferred from the old owner to the new owner.

In this paper we present a first sketch of a formal framework to represent and analyze the dynamics of transferable obligations. This framework is a combination of different modal logics, of which deontic logic is the most prominent one. In this paper we do not introduce new logics. Rather we show how a proper combination of two existing logics can be used for the modeling and analysis of international trade procedures. The framework should provide concepts that are adequate to construct the, what we will call, Deontic Deep Structure Model (DDSM) behind the procedures. This deontic deep structure plays an important role in the (re)design of procedures.

1.2 A redesign methodology based on deontic deep structure models

In the case of (re)design of procedures it is essential to understand the underlying functionality of the procedure. For what purpose was the procedure introduced? Why were certain documents introduced? And, more specifically for redesign, is the procedure still needed, or can the underlying functionality be implemented by a more efficient procedure. This last question is in particular interesting in the case of the 'electronification' of a procedure in electronic commerce; i.e. adapting procedures to make them applicable in electronic networks environments. Currently, the usual redesign approach is simply to replace paper-based documents one-to-one by electronic data interchange (EDI) documents, but this approach does not make the best use of the potential of electronification (see e.g. [7]). In particular, electronifying every document in a procedure does not address the issue whether parts of or even the whole procedure is still needed in an electronic environment. One could describe the currently dominant approach to electronify documents one-to-one into their electronic counterparts as a type of superficial redesign. In contrast with a type of redesign, which one could call deep redesign, that is based on first modeling the underlying functionality of the whole procedure.

What should such a model of the underlying functionality look like? In many procedures documents play a crucial role. For example, passport for identification, import or export clearance documents, bills of lading in international sea transport. The purpose of most of these documents is fraud prevention or detection. In general, one could say that fraud means that somebody violated his obligation to do action p, while he pretends to have done p. Fraud is easy, when it is hard for the victim to detect it. For example, in the international trade example discussed above the seller could deceive the buyer by sending a forged bill of lading without shipping any goods. In this case the seller violated his obligation to ship the goods, while he pretended to have fulfilled his obligation by sending the forged bill of lading. In order to prevent this type of fraud, it is usually required that a representative of the transport company signs the bill of lading. Another fraud risk of the bill of lading is that its uniqueness has to be secured. Since the buyer can use this document to exercise his right to claim the goods, it is essential that there are no copies of this document. Also this fraud risk can be reduced by having a signature on the document. In addition to these two functions there are yet another dozen functions that the bill of lading must have in order to prevent the different types of fraud risk that are related to the underlying obligations and rights. In the redesign process it is essential to preserve these functions of the bill of lading. How do you secure, for example, the uniqueness of bill of lading if it is replaced by an electronic message that can be copied millions of time without leaving a trace? This can be solved by adding an electronic signature to the electronic bill of lading. However, this electronic signature, based on public key cryptography technology, is quite different from the signature on a paper document. For example, the use of electronic signatures requires the introduction of an extra party on the electronic network, the so-called trusted third parties, that act as notaries for the distribution of the public keys. These fraud prevention and detection functions of a document are best analyzed in relation to the obligations and rights that they are supposed to secure. Since obligations are essential for fraud analysis, it is an obvious choice that the underlying functionality of procedures should be analyzed in a deontic model. The formal framework presented in this paper should provide the logical concepts for this deontic deep structure model of a procedure.

The ultimate objective of the research at Euridis is to develop a computer-supported methodology for procedure redesign that consists of the following three phases that are represented in Figure 1. First, a deontic deep structure model of the existing procedure is developed. Secondly, to this model we apply a library of heuristics that can be used to reduce the risk of fraud related to this specific deontic deep structure model. These heuristics take as input this deontic model, and they produce as output a template for a procedure that include paper or EDI documents which give optimal protection against potential fraud. The third phase is that these templates are graphically represented as Petri nets, which are generated with the modeling tool Case/EDI that was developed at Euridis (e.g. see [1]). The heuristics for an electronic

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environment might be different from a paper-based environment. For example, implementing a signature on a paper document is completely different from implementing an electronic signature on an electronic message. Another example is that in an appropriately secured electronic environment the EDI version of a passport might be no longer needed, because the communication protocol is defined in such a way that nobody can present himself on the network as another person.

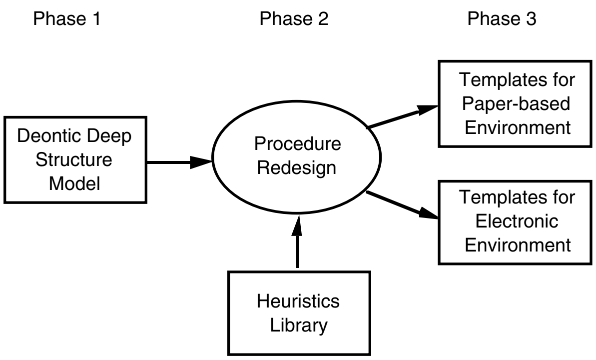

Figure 1. Redesign methodology

Although there are currently techniques available to implement modal logics (see e.g. [5]), it is not the primary objective of our research to make the logics in the framework itself computer executable. These logics are used for representation rather than complex reasoning. In the deontic deep structure models all the relevant aspects of the underlying obligations and rights are supposed to be explicitly represented, hence very little extra reasoning about these deontic aspects is required. Also applying the heuristics to the deontic deep structure models is more a pattern recognition than a complex reasoning process.

The outline of this paper is as follows. In section 2 and 3 we present several logics that are incorporated in the formal framework in order to make it suitable for representation of obligations in procedures. In section 4 we will informally discuss some examples. In section 5 we show how the formal framework is applied to provide a deontic deep structure model of the examples. In section 6 we draw some conclusions and discuss some further extensions of the framework.

2. The logic of directed obligations

In many business situations it is important to model the obligations between different agents (e.g. in trade: buyer, seller, transport company, stevedore, freight forwarder, customs offices etc.). Most of these obligations can be viewed as relations between two agents. For example, the obligation to pay for delivered goods is directed, so to say, from the buyer to the seller. In order to model this aspect of obligations, we need a notion of directed obligations in our framework. A suitable notion of *directed obligations* is provided by the logic of Herrestad and Krogh (Herrestad and Krogh, 1995). They give the following example to illustrate the notion of directed obligation. Suppose i and j have a contract which states that: ‘i ought to pay j 1000 ECU’. This contract implies a directed obligation from i to j that i brings about that j receives 1000 ECU. They argue that this contract implies a combination of a bearer-relativised ought-to-*do* obligation on i to bring about that j receives 1000 ECU, and a counterparty-relativised ought-to-*be* statement relative to j that i brings about that j receives 1000 ECU. Hence, they propose to define a directed obligation as a conjunction of a bearer-relativised ought-to-do obligation for i (${}_iO$) that i brings about that A and an ought-to-be statement relativised to a counterparty j (O_j) that i brings about that A:

$${}_iO_j({}_iEA) =_{def} {}_iO({}_iEA) \wedge O_j({}_iEA)$$

In this definition ${}_iEA$ is an action operator which denotes that agent i brings about state A. This definition says that: “i is obliged towards j that i sees to it that A, if and only if, it is obligatory for i that i sees to it that A, and for j it ought-to-be that i brings about that A.” From a legal point of view one could consider j in the operator O_j as the claimant that can bring a violation of the obligation to court. Each operator ${}_iO$ is regarded as a relativised SDL operator; i.e. as having a normal modal logic that satisfies the two axioms

[K] $\quad {}_iO(A \rightarrow B) \rightarrow ({}_iOA \rightarrow {}_iOB)$

[D] $\quad {}_iOA \rightarrow \neg{}_iO\neg A$.

The semantics are given by a model-structure: M = < W, R, I, P >, where W is a set of worlds $\{w_1, w_2, w_3, ..\}$. P is a valuation function which assigns the values true or false to a sentence at a world in W, I is a set of individuals $\{i_1, i_2, .. , i_n\}$, and R is a set of functions $\{R_1, R_2, ..., R_n\}$ for each individual $i_1, i_2, .. , i_n \in I$. Each member of R takes a member of W and returns a subset of W; i.e. $R_i : W \rightarrow Pow(W)$. The intuition behind the functions in R is that each individual has a function which returns the deontically ideal worlds (for that individual) given a world. The semantic notion of *ideality* is interpreted as a preference for worlds where all obligations holding in w, the world of evaluation, are fulfilled. For the bearer-relativised obligation operator the following truth

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conditions suffice ($\|A\|$ denotes the set of worlds in which the formula A is true): M, w $\models$ ${}_iOA$ iff $R_i(w) \subseteq \|A\|$, which means that ${}_iOA$ is true at a world w in the model M, if and only if, A is true at all worlds that are ideal relative to w. Herrestad and Krogh assume that the semantics of the O_j is similar to the one of the ${}_iO$ operator. The logic of ${}_iE$ is supposed to be a minimal modal logic of type ET.

3. The logic of (in)direct action

In many business situations an agent has the obligation to do something, but he is delegating the execution of this action to another agent. The boss in an organization can delegate the tasks he is obliged to do to a subordinate. A seller of goods can hire a transport company to deliver the goods at the place of the buyer, if it was stipulated in the contract that the seller was obliged to do so. Delegating the execution of a task to another agent is sometimes called indirect action.

In their logic Herrestad and Krogh use the action operator ${}_iE$, representing "i brings it about" or "i sees to it that". In their definition of this operator no distinction is made between direct and indirect action. In other words, in ${}_iEA$ it is not clear whether agent i himself is bringing about A, or that another person is doing it for him. In (Santos and Carmo, 1996) Santos and Carmo argue that it is of vital importance for modeling in organizational analysis to make this distinction. They even suggest to introduce two different operators to represent this distinction formally, namely ${}_iE$ and ${}_iG$. They start with the following axioms for the ${}_iE$ operator

[T] ${}_iEA \rightarrow A$

[C] $({}_iEA \wedge {}_iEB) \rightarrow {}_iE(A \wedge B)$

[RE] If $\vdash A \leftrightarrow B$ then $\vdash {}_iEA \leftrightarrow {}_iEB$

The [T] schema captures the intuition that if agent i brings it about that A, then A is indeed the case (${}_iE$ is a 'success' operator). The [C] schema presupposes co-temporality. The [RE] schema is closure under logical equivalence. Santos and Carmo discuss which of the following properties should be accepted:

[EEE] ${}_iE_jEA \rightarrow {}_iEA$

[EE¬E] ${}_iE_jEA \rightarrow \neg{}_iEA$

Accepting [EEE] would mean that an agent may "bring about" indirectly (by using another agent). Accepting [EE ¬E] is a way of insisting that ${}_iEA$ means that agent i must bring it about that A is the case by himself (directly). The claim of Santos and Carmo is that we need both notions. Therefor they introduce a new operator ${}_iG$, read as "agent i ensures that", which denotes indirect action. We accept for ${}_iE$ the additional axiom [EE¬E]. This means that we will read ${}_iEA$ as "agent i executes A (with his own hands)". The operator ${}_iG$ has the following formal properties:

[T] ${}_iGA \rightarrow A$

[C] $({}_iGA \wedge {}_iGB) \rightarrow {}_iG(A \wedge B)$

[RE] If $\vdash A \leftrightarrow B$ then $\vdash {}_iGA \leftrightarrow {}_iGB$

[GGG] ${}_iG_jGA \rightarrow {}_iGA$

With schema [GGG] having the following reading: "whenever agent i ensures that agent j ensures that A, agent i also ensures that A". With respect to the relationships between the different agency operators (the direct and indirect), we should accept (at least) the following reasonable principles:

[EG] ${}_iEA \rightarrow {}_iGA$

[GEGG] ${}_iG_jEA \rightarrow {}_iG_jGA$

[EEEG] ${}_iE_jEA \rightarrow {}_iE_jGA$

[EGE] ${}_iEA \rightarrow {}_iG\,{}_iEA$

The first principle is fundamental and states that "whenever agent i brings it about that A, agent i also ensures that A" (bringing about is a particular case of ensuring). The other two state respectively that "whenever i ensures that j brings it about A, i also ensures that j ensures that A" and "whenever i brings it about that j brings it about A, i also brings it about that j ensures A". The last one states that "whenever agent i brings it about that A, i ensures that i brings it about A".

The semantics of ${}_iG$ are given by a model structure: M = <W, G, P, I >, where W is interpreted as a set of worlds $\{ w_1, w_2, w_3, .. \}$, P is a valuation function which assigns the values true or false to a sentence at a world in W. I is a set of individuals $\{i_1, i_2, .. ,i_n\}$, and G is a set of functions $\{g_1, g_2, ..., g_n\}$ for each individual $i_1, i_2, .. , i_n \in$ I. Each member of G is a function with signature Pow(W) $\rightarrow$ Pow(W), and takes a subset of W representing some state of affairs and returns a subset of this subset for which i has ensured this state of affairs. So $g_i(X)$ means the set of worlds where individual i *ensures* (the state of affairs described by) X. The truth at a world for expressions of the form ${}_iGA$ is defined by:

$$M,w \models {}_iGA \text{ iff } w \in g_i(\|A\|)$$

To validate the desired schemata for ${}_iG$, the following constraints on the model M are imposed: for all X and Y subsets of W,

(t_g)	$g_i(X) \subseteq X$
(c_g)	$(g_i(X) \cap g_i(Y)) \subseteq g_i(X \cap Y)$
(ggg)	$g_i(g_j(X)) \subseteq g_i(X)$

In order to consider the relationships between the operators ${}_iG$ and ${}_iE$, the previous model should be extended with functions $(f_i,...,f_n)$ with signature Pow(W) $\rightarrow$ Pow(W), where $f_i(X)$ means the set of worlds where agent i executes X; define

$$M, w \models {}_iEA \text{ iff } w \in f_i(\|A\|)$$

and impose the constraints to validate the schemata [T], [C] and [EE¬E] for ${}_iE$:

(t_e)	$f_i(X) \subseteq X$
(c_e)	$(f_i(X) \cap f_i(Y)) \subseteq f_i(X \cap Y)$
(ee¬e)	$f_i(f_j(X) \subseteq -f_i(X)$ (for $i \neq j$)

Here $-f_i(X)$ denotes the complement of $f_i(X)$ in W. Finally, the semantic counterparts of [EG], [GEGG], [EEEG] and [EGE] are obtained by imposing:

(eg)	$f_i(X) \subseteq g_i(X)$
(gegg)	$g_i(f_i(X)) \subseteq g_i(g_j(X))$
(eeeg)	$f_i(f_j(X)) \subseteq f_i(g_j(X))$
(ege)	$f_i(X) \subseteq g_i(f_i(X))$

Santos and Carmo state that their operators ${}_iE$ and ${}_iG$ are particularly useful to capture the notion of responsibility in an organization. These operators are also useful for modeling certain aspects of obligations in inter-organizational situations. The formal framework that we discussed in the introduction is based on the combination of the two logics from Herrestad and Krogh, and Santos and Carmo. The way we combine these two logics is that within the logic of Herrestad and Krogh we replace the semantics of their operator ${}_iE$ by the semantics of the operators ${}_iE$ and ${}_iG$ of Santos and Carmo. This combination does not create technical problems, because both ${}_iE$ and ${}_iG$ have a minimal modal ET type of logic, which was the only requirement by the logic of Herrestad and Krogh. The logic of Herrestad and Krogh is very suitable to model the directedness aspects of obligations, but their notion of 'bringing about' is a bit restrictive, in particular if we want to model certain aspects of the transferability of obligations. The advantage of the logic of Santos and Carmo is that their logic provides a very subtle formal framework for the representation of indirect action. This notion of indirect action plays an important role in the modeling of transferable obligations in which an agents fulfills his obligation by having another agent that executes the fulfilling action for him.

4. Some examples from international trade

In this section we informally discuss some examples of which the deontic deep structure models will be given in the next section.

Example 1: Transport Scenario

Consider a simple trade transaction between a buyer (agent B) and a seller (agent S). In the initial state none of the agents has an obligation towards each other. The first step in the contract negotiation process is that both agents agree to the terms of a purchase order. This agreement creates an obligation for the seller to deliver certain goods and in return it creates an obligation for the buyer to pay for the goods. The resulting situation is shown in state 1 of Figure 2. The seller can either deliver the goods himself (direct action) or hire somebody to do it for him (indirect action). Let us assume S does it the indirect way, then the second state is that the seller makes a contract with a transport company T that T will deliver the goods to the buyer after the seller has paid the transportation costs. We also assume in this example that it is stipulated in the contract that T is not allowed to subcontract this transport. (Such a condition is sometimes made if the transport company is chosen for his specific skill in transporting certain type of goods, e.g. the personal grand piano of Horowitz.) Hence, the transport is a direct action for the transport company. An interesting aspect of this example is that in spite of the fact that the transport company has the obligation to transport the goods to the buyer, this obligation is not towards the buyer, but only towards the seller. In case of non-delivery of the goods the buyer will make a claim against the seller, and not against the transport company. Of course, if the seller is sued by the buyer, then the seller in his turn will make a claim against the transport company for non-delivery, but that is another matter. We will see that this aspect is reflected in the deontic deep structure model.

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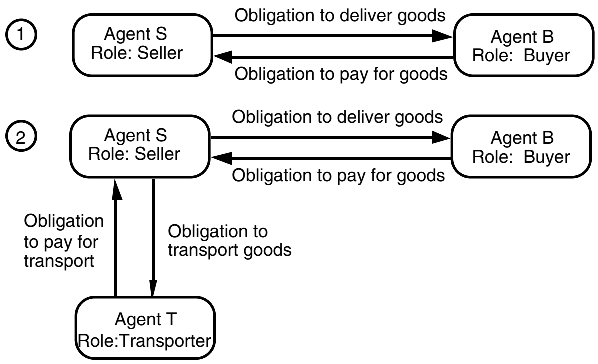

Figure 2. Transport scenario

Example 2: Transfer of Bill of Lading

The holder of a Bill of Lading (BoL) can exercise his right to claim the goods from the transport company. Reciprocally, the transport company has an obligation to deliver the goods to the holder of the bill of lading. In the initial state 1 in Figure 3 the buyer B, that pre-paid the goods, holds the bill of lading. Now we assume in state 2 that B sells the goods to another agent, the new buyer N. This includes the obligation that B gives the bill of lading to N, and in return N is obliged to pay for the goods. Because the holder of the bill of lading changes from agent B to agent N, the obligation for the transport company to deliver the goods also changes. This is what we call a transfer of rights. The right of agent B is transferred to agent N.

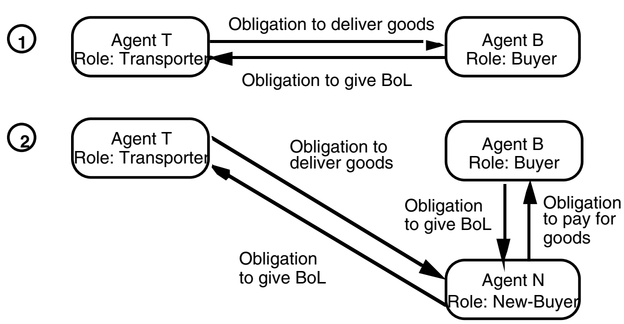

Figure 3. Transfer of bill of lading

5. Deontic deep structure models for the examples

In this section we illustrate how a deontic deep structure model for each of the examples from the previous section is represented in the formal framework. The deontic deep structure model for Example 1 shows that we have to formally distinguish between direct and indirect agency, i.e. to distinguish between the ${}_iG$ and ${}_iE$ operators.

Figure 4 is the deontic deep structure model for Example 1. In the initial state none of the agents has an obligation. The contract 1 about sale of goods between seller S and buyer B yields the transition from state 1 to state 2. The symbol *D* represents the delivery action and *M* represents the payment action. In state 2 we see that both agent S and agent B have an obligation. The contract 2 between agent S and agent T concerning the delivery yields the next transition. In state 3 the seller S and the transport company T have a new obligation because of contract 2. The transfer of agency of the delivery of the goods is reflected by the introduction of the new obligation tOs(tED) in state 3. The delivery D is a direct action for T (as stipulated in contract 2), and an indirect action for S, which is represented by the obligation sOb(sGD). The transfer of agency from agent S to agent T causes new reciprocal obligations, none of the previous obligations have disappeared. Hence, this example shows that agency transfer does not release the bearer of his responsibility to fulfill his initial obligation to deliver the goods. In particular, the agent S is still liable for non-delivery of the goods by agent T. If T does not deliver the goods, then agent B makes the damage claim related to this non-delivery against agent S, not against agent T. This is reflected by the fact that in the obligation sOb(sGD) agent B can still make a claim against agent S. Of course, in case of such a claim from B against S, the latter agent will make a claim against agent T, but these are two different claims. As we explained in section 1 the operator O_j represents who can claim in the case of violation of the obligation. Therefore, we consider that in this example sOb(sGD) is still an obligation that has to be fulfilled by S, hence S only transferred his agency of the delivery of the goods, not his liability. The fact that, in case of a non-delivery claim by B, S can make a claim against T, is reflected in the obligation tOs(tGD), where S is the claimant with respect to T if there is non-delivery of goods.

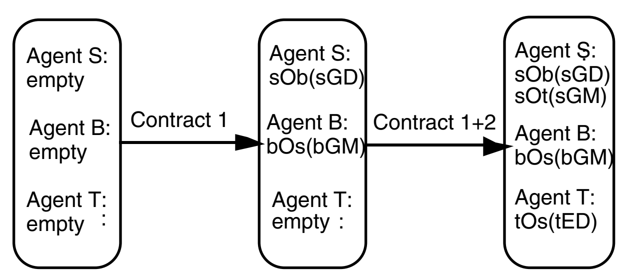

Figure 4. Deontic deep structure model for trade scenario

In Figure 5 the deontic deep structure for the Bill of Lading example is shown. Let B denote the giving of the bill of lading, D delivery of goods and M giving money. In state 1 of Figure 5 the transport company T has an obligation to deliver the goods to the buyer B, who holds the bill of lading, because he pre-paid the goods.

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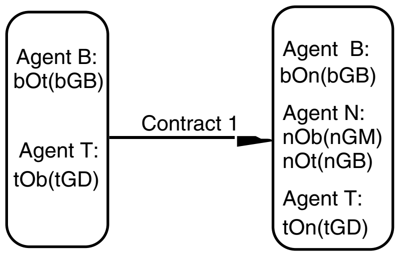

Figure 5. Deontic deep structure model for bill of lading transfer

The buyer is obliged to give the bill of lading to the transport company. Subsequently, in state 2 the buyer sells the goods by contract 1 to the new buyer N, which includes that the buyer is obliged to give the bill of lading to the new buyer. In return the new buyer is obliged to pay for the goods. Hence, the right to claim the goods is transferred from agent B to agent N. This is represented in state 2 of the Deontic Deep Structure Model. The transport company's obligation has changed from tOb(tGD) to tOn(tGD). So, the counterparty of the transport company's obligation has changed from agent B to agent N. In addition to this transfer of rights two new obligations are created; namely bOn(bGB) and nOb(nGM). The first represents that agent B has to transfer the bill of lading to agent N. The latter represents that agent N has to pay money to agent B.

6. Conclusions and further research

In this paper we presented a first sketch of a formal framework for representing deontic deep structure models for trade procedures. This framework is based on a proper combination of the deontic logic of Herrestad and Krogh and the action logic of Santos and Carmo. We illustrated with two examples how the formal framework can be applied to analyze some international trade procedures in which obligations are transferred from one agent to another agent. In future research we plan to extend the framework in the following ways..

In this paper the state transitions in the deontic deep structure models are described informally. From a formal point of view these state transitions can be analyzed as actions that are brought about by illocutionary acts such as committing oneself to an agreement by signing a contract. We plan to investigate to what extent it is possible to represent this dynamic behaviour of transferable obligations in the illocutionary deontic logic of [2] that is based on dynamic logic.

Another issue is the dependency between obligations within a state of the deontic deep structure model. For example, the obligation of the seller to deliver goods precedes the obligation of the buyer to pay for them. As we discussed in the introduction this dependency becomes more complicated in international trade situations. The buyer in Hong Kong is obliged to pay for the goods when the seller has shipped them in Rotterdam. But how can the buyer be sure that the seller did what he promised to do, namely shipping the goods? One solution is that the seller sends the buyer a bill of lading, i.e. a document that is sufficient evidence for the buyer to believe that the seller fulfilled his obligation. But this implies that the fulfilment of the payment obligation is conditional on the belief that the buyer has about the seller. To model this aspect of the dependency we should include in our framework also epistemic logic, the logic of knowledge and belief (for a survey see [4]). Moreover, belief might be changed due to new information. The buyer might retract his belief that the seller shipped the goods if he gets new information that indicates that the bill of lading was forged. Retracting a belief, and also retracting the results of actions that were caused by this belief (e.g. the pre-payment of the goods), is a typical example of defeasible or non-monotonic reasoning. To model this kind of processes we also have to include non-monotonic logic in our framework.

7. Acknowledgments

We want to thank Roger Bons, Ron Lee and Leon van der Torre for discussions on issues addressed in this paper.

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Proceedings of The Thirtieth Annual Hawwaii International Conference
on System Sciences ISBN 0-8186-7862-3/97 $17.00 © 1997 IEEE