Diagnosing Commitments: Delegation Revisited
(Extended Abstract)

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ABSTRACT

The success of contract-based multiagent systems relies on agents complying with their commitments. When something goes wrong, the key to diagnosis lies within the commitments' mutual relations as well as their individual states. Accordingly, we explore how commitments are related through the three-agent commitment delegation operation. We then propose exception diagnosis based on such a relation.

Categories and Subject Descriptors

I.2.11 [**Distributed Artificial Intelligence**]: Multiagent Systems

General Terms

Verification

Keywords

Agent commitments, Distributed problem solving, Reasoning (single and multiagent)

1. INTRODUCTION

A commitment describes a contract between two agents: the debtor commits to satisfy a property for the creditor. In a contract-based multiagent system, several such commitments are in effect, e.g., the merchant is committed to deliver the goods when the customer pays. This is represented by a conditional commitment:

$$CC(merchant, customer, paid, delivered).$$

Often, agents delegate their commitments to others. For example, C(*courier*, *merchant*, *delivered*) is a delegation of CC(*merchant*, *customer*, *paid*, *delivered*) where the merchant delegates the task of delivery to the courier.

When there are many such commitments in the system at hand, in order to diagnose an exception we need effective ways to explore the space of commitments. In particular, we need to identify links between commitments and exclude from our search the irrelevant instances. To this end, we propose a similarity relation to relate commitments with each other. Through the relations, we identify what has gone wrong when there is an exception.

2. DELEGATION OF COMMITMENTS

DEFINITION 1. *A **delegation** of a commitment CC (X, Y, Q, P), called **primary**, is a new commitment where either X or Y plays the role of the creditor or debtor, and a new agent Z is responsible for bringing about the antecedent Q or the consequent P.* ∎

Six types of delegation are particularly meaningful. Only some of them have been considered in previous literature.
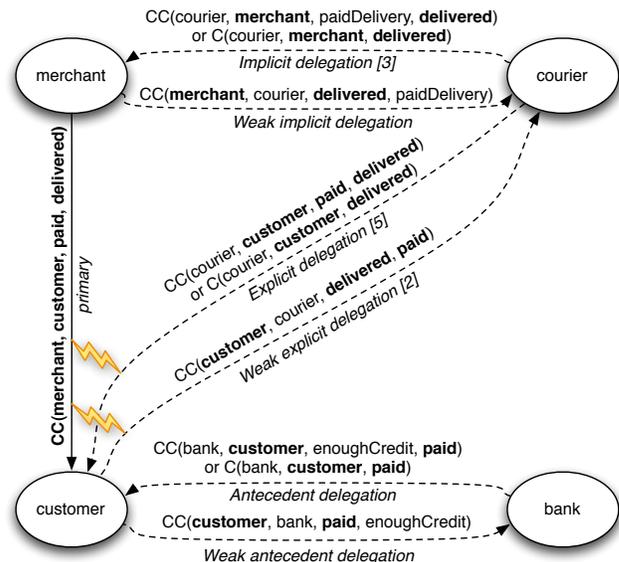

Figure 1: Sample Delegations

DEFINITION 2. *(Explicit delegation) The primary is canceled and a new commitment CC (Z, Y, Q, P) is created. That is, a new debtor is committed to the same creditor. This delegation operation was proposed by Yolum and Singh [5].* ∎

DEFINITION 3. *(Weak explicit delegation) The primary is canceled and a new commitment CC (Y, Z, P, Q) is created. That is, the creditor Y of the primary is now the debtor of the new commitment, and Y wishes to achieve P via a new creditor Z. This is a weak delegation to achieve P since there is no obligation for Z to satisfy P unless Z needs Q satisfied. The concept of weak delegation is inspired by Chopra et al.'s work [2].* ∎

DEFINITION 4. *(Implicit delegation) While the primary is still active, a new commitment CC (Z, X, R, P) is created. That is, the debtor X of the primary is now the creditor of a new commitment for the same consequent P. This type of delegation chain (e.g., two dependent commitments) was proposed by Kafalı et al. [3].* ∎

DEFINITION 5. *(Weak implicit delegation) While the primary is still active, a new commitment CC (X, Z, P, R) is created. That is, the debtor X of the primary also becomes the debtor of a new commitment where the antecedent P is the primary's consequent.* ∎

DEFINITION 6. *(Antecedent delegation) While the primary is still active, a new commitment CC (Z, Y, R, Q) is created. That is, the creditor Y of the primary also becomes the creditor of a new commitment for the antecedent Q of the primary. We propose this to connect delegations in a chain-like structure.* ∎

DEFINITION 7. *(Weak antecedent delegation) While the primary is still active, a new commitment CC (Y, Z, Q, R) is created. That is, the creditor Y of the primary is now the debtor of a new commitment which has the same antecedent Q as the primary.* ∎

The above definitions can be extended to base-level commitments. In addition, (weak) explicit delegation can be extended to have an antecedent R different from Q. Also note that a special case of (weak) implicit delegation is where R equals Q. Figure 1 gives some examples of commitment delegation.

We say that a commitment is **delegation-similar** to another commitment if one is a delegation of the other according to Definitions 2-7. If we only consider "rational" delegations, where the responsibilities of roles in relation with the primary's properties are preserved, then our account of commitment delegation is exhaustive.

3. DIAGNOSIS

Full details on delegation-similarity and on the diagnosis process can be found in [4]. Here, we only provide the main definitions and an illustration.

DEFINITION 8. *A diagnosis framework $\mathcal{F}$ is a tuple $<\mathcal{P}, \mathcal{R}, \mathcal{A}, \mathcal{T}, \mathcal{D}>$, where $\mathcal{P}$ is a set of conditional commitments, representing a protocol [2, 5], $\mathcal{R}$ is a set of roles, each consisting of a subset of $\mathcal{P}$'s commitments and a set of action descriptions, $\mathcal{A}$ is a set of agents enacting roles in $\mathcal{R}$, $\mathcal{T}$ is an event trace, e.g., a set of actions performed at specific time points, and $\mathcal{D}$ is a diagnosis process.* ∎

Commitments in $\mathcal{P}$ are abstract entities, i.e., templates that include roles from $\mathcal{R}$ in place of agents. Table 1 shows part of the protocol components for acquiring a credit card. When the agents in $\mathcal{A}$ are bound to the roles in $\mathcal{P}$, the commitments become real. The trace of events $\mathcal{T}$ describes a specific protocol execution, by which commitments change state accordingly [5]. A diagnosis process $\mathcal{D}$ can be initiated throughout $\mathcal{T}$ upon a commitment violation, which maps a diagnosis point $\mathcal{D}_i$ to a diagnosis outcome $\mathcal{D}_o$. The diagnosis point $\mathcal{D}_i$ consists of a violated base-level commitment C_i and a time point T. Based on the current set of commitments $\mathcal{C}_T = \{C_1, ..., C_i, ..., C_n\}$ at T, the diagnosis outcome $\mathcal{D}_o$ associates a commitment $C_o \in \mathcal{C}_T$ that has caused the violation of C_i.

Reasoning of $\mathcal{D}$ is based on the delegation-similarity relation. Let us consider the protocol in Table 1. The numbers inside the consequents represent the deadlines for the commitments, e.g., the *bank* must deliver the card within 7 days of the customer's request (CC_1). When the card is *requested*, the *bank* notifies the *office* for printing the card (CC_3). Then, the *courier* delivers the card to the *client* (CC_2). The client's role only includes the commitment CC_1 and two actions, for requesting and getting the card delivered. The last row of Table 1 shows which agents enact the corresponding roles in the protocol. Consider now the following trace:

$$\mathcal{T} = \left\{ \begin{array}{lll} 1 & request(cli, ban) & \text{(the client requests the credit} \\ & & \text{card from the bank on day 1)} \\ 4 & confirm(ban, off) & \text{(the bank confirms the request)} \\ 7 & print(off, cou) & \text{(the office produces the card and} \\ & & \text{passes it to the courier)} \end{array} \right.$$

$$\mathcal{P}_{card} = \{CC_1(bank, client, requested, delivered(7)),$$
$$CC_2(courier, bank, printed, delivered(3)),$$
$$CC_3(office, bank, confirmed, printed(3))\}$$
$$\dots$$
$$\mathcal{R}_{client} = \{CC_1, request(client, bank) \rightarrow requested,$$
$$deliver(\_, client) \rightarrow delivered\}$$
$$\dots$$
$$\mathcal{A} = \{bank(ban), client(cli), courier(cou), office(off)\}$$

Table 1: Acquire credit card ($\mathcal{P}_{card}$)

The following commitments are in place at time 8:

$$\mathcal{C}_8 = \left\{ \begin{array}{l} C_1(bank, client, delivered(8)) \\ CC_2(courier, bank, printed, delivered(3)) \\ C_3(office, bank, printed(7)) \end{array} \right.$$

Notice the pattern among these three commitments; CC_2 is an implicit delegation of C_1 (Definition 4), and C_3 is an antecedent delegation of CC_2 (Definition 6). Then C_3 is delegation-similar to C_1 via CC_2.

Now assume that no delivery has occurred until time 9. C_1 is indeed violated since its deadline has passed and *delivered* has not been brought about. Because of the delegation-similarity relation, CC_2 and C_3's deadlines together affect C_1. Even though the printing of the card is completed at day 7, the courier has 3 more days for delivery, which will eventually exceed C_1's deadline. Here, the bank should have confirmed the client's request earlier, and notified the office accordingly.

4. DISCUSSION

This paper advances the state of the art in several directions. We identify the ways that a commitment can be extended with a third party (e.g., a delegatee agent). We exploit the commitment delegation operation to address related exceptions. Such an exhaustive study on commitment delegation had never been published before. Moreover, our similarity relations also account for the regulative perspective [1] of contract execution as well as the well-known constitutive side of commitment protocols.

Due to space limitations, we only mentioned some of the other key features of our commitment diagnosis framework. In [4], we give a more elaborate account of temporal constraints and we discuss prognosis alongside diagnosis.

5. REFERENCES

[1] M. Baldoni, C. Baroglio, and E. Marengo. Behavior-oriented commitment-based protocols. In *Proc. ECAI 2010*, pages 137–142. IOS Press, 2010.

[2] A. K. Chopra, F. Dalpiaz, P. Giorgini, and J. Mylopoulos. Reasoning about agents and protocols via goals and commitments. In *Proc. AAMAS'10*, pages 457–464, 2010.

[3] Ö. Kafalı, F. Chesani, and P. Torroni. What happened to my commitment? Exception diagnosis among misalignment and misbehavior. In *Proc. CLIMA XI*, *LNCS* 6245, pages 82–98, 2010.

[4] Ö. Kafalı and P. Torroni. Diagnosing commitments: Delegation revisited. Technical Report DEIS-LIA-11-001, University of Bologna (Italy), Feb. 2011. LIA Series no. 99.

[5] P. Yolum and M. P. Singh. Flexible protocol specification and execution: applying event calculus planning using commitments. In *Proc. AAMAS'02*, pages 527–534, 2002.