Value-based Design of Networked Enterprises Using *e^3control* Patterns

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Abstract

Networked organisations, consisting of enterprises who exchange things of economic value with each other, often have participants who commit a fraud or perform other actions, not agreed in a contract. To explore such opportunistic behaviour, and *to design solutions to mitigate it, we propose the* e^3control *approach. This approach takes the valuable objects, which are exchanged between enterprises, as a point of departure, and proposes a control patterns library to find solutions for various types of opportunistic behavior in network organisations. The practical use of the patterns are illustrated by a case study in the field of renewable electricity supply in UK.*

1 Introduction

In recent years, organizations increasingly organize themselves as networks: collections of enterprises that jointly satisfy a complex consumer need, each utilizing their own specific expertise, products, and services [24]. Such networks are enabled by technologies such as web-services and the widely spread use of the Internet itself. In earlier work on *e^3value* [10], we have reported how to explore such an IT-enabled network from a *business value* perspective. The *e^3value* approach deliberately supposes that enterprises behave *honestly* to reduce complexity modeling complexity; to our experience, it is initially already sufficiently difficult to design a network under such perfect-world conditions. A next step is to assume *opportunistic* behavior, for which we have proposed *e^3control* [14], as an additional modeling perspective. Solutions for addressing such behavior requires often a particular arrangment of business processes, which may influence the *e^3value* model of a network, but which also direct requirements for information systems.

To address and discourage opportunistic behavior, *control mechanisms* can be applied. Design of such controls in *networks* has additional complexity; controls in *networks* are typically not imposed on the network by one central organization as is the case for just *single* enterprises, but are negotiated among all network participants. During this negotiation process, stakeholders (e.g. business analysts, system developers, CIOs, CEOs) typically use natural language to represent and communicate their statements. However, stakeholders often have different views on control problems and solutions and different interests, which, when communicated in natural language, may lead to incomplete and ambiguous statements [19].

To design controls in networked enterprises, *e^3control* can be used, but to our experience, the design process still requires a vast amount of knowledge on organizational controls *themselves*. To make this knowledge available within *e^3control* , we propose a library of *control patterns*, which describes *organizational controls* for networked organizations. The considered controls are collected from theories in business literature, in particular agency theory (e.g. [6]) internal control theory (e.g. [22]) and management control theory (e.g. [2]). Examples of organizational controls are different kinds of monitoring and verification activities, e.g. quality control, reconciliation of accounting records with material reality, as well as preventative controls, such as economic incentives. Additionally, the patterns are based on four real-life case studies we performed in the drinks industry [15], electricity supply industry [16], international trade [17], and the entertainment industry [13].

The e^3*control* approach and the patterns are unique because they are grounded in an *economic value* perspective. It is the transfer of valuable objects in a network that has to be controlled in first place. This contrasts to process-oriented approaches for controls (see e.g. [22]), or even EDP-auditing (e.g. [11]).

This paper first introduces the notion of value-based controls for networked value constellations (Sec. 2). Then, we present two of our control patterns in detail in Sec. 3 as well a summary of the rest of the patterns. In Sec. 4, we show the two patterns can be practically applied in a case study. Finally, Sec. 5 presents our conclusions.

2 Value-based design of controls for networked constellations

2.1 Value controls for networked value constellations

Design of controls usually boils down to securing and auditing information systems (EDP auditing, see e.g. [11]) and supposes an understanding of business processes [22]. In addition to that, we propose an *economic value*-aware approach. Based on a series of case studies [12, 16, 14], a value-based approach of control design can be motivated as follows. First, in a network, valuable objects (goods, services, money) are transferred between enterprises. Since the *correct* transfer of these objects is the foundation for a sustainable operation of the network, it is important to understand the enterprises and their transfers in the first place. Second, networks, as they consist of financially-independent units, are interested in their own profitability. Controls, which essentially are services with an own price tag (e.g. eTrust), require financial resources, thus have effects on the sustainability of an enterprise. Finally, controls can even lead to new business opportunities and new networks. For example, our analysis of health care quality controls in the Netherlands led to the development of a new business model of community-based quality control by means of an interactive web-site [5, 16].

In this paper, we contribute a pattern-based approach to design controls. These patterns utilize earlier work on e^3*value* [10] and e^3*control* [14] modeling, which we briefly summarize below.

2.2 Designing value controls

From a control perspective, we distinguish two states of a network of organizations: (1) *no* opportunistic behavior or fraud occurs; we call this an *ideal situation*, and (2) opportunistic behavior or fraud *does* occur; we call this a *sub-ideal situation*. We suggest that designing controls should include at least the following subsequent three steps.

2.2.1 Step 1: State the *ideal* networked value constellation using an e^3*value* model

An e^3*value* model incorporates modeling concepts to represent which parties in a network organization exchange which objects of economic value with which parties. Fig. 1 shows an example of a buyer who obtains goods from a seller and offers a payment in return. According to the law, the seller is obliged to pay a value-added tax (VAT). This can be conceptualized with the following e^3*value* constructs (in bold).

Actors, such as the buyer, seller, and the tax office are economically independent entities. Actors transfer **value objects** (payment, goods, VAT) by means of **value transfers**. For value objects, some actor should be willing to pay, which is shown by a **value interface**. A value interface models the *principle of economic reciprocity*: only if you pay, you can obtain the goods and vice versa. A value interface consists of **value ports**, which represent that value objects are offered to and requested from the actor's environment. Actors may have a **consumer need**, which, following a path of dependencies will result in the exchange of value objects. Transfers may be **dependent** on other transfers, or lead to a **boundary element**. Then no transfers are considered anymore.

The important point here is that an e^3*value* model *by definition* supposes that all actors behave ideally. This is reflected by the explicit notion of 'economic reciprocity': all agreed transfers are required to happen, or should not happen at all. Performing this step results in understanding of the valuable objects that should be transferred, and thus which objects should be subject to control.

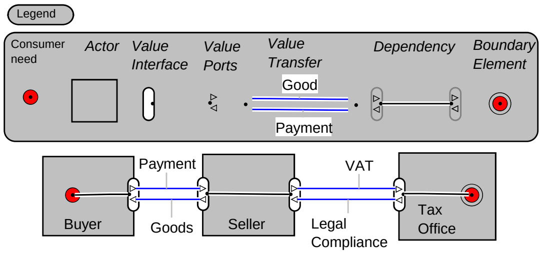


Figure 1. Example of an ideal e^3*control* model of a purchase with tax payment

2.2.2 Step 2: Analyze *sub-ideality* in networked constellations using an e^3*control* model

In reality, actors ideal often behave sub-ideally: they commit a fraud or make unintentional errors. In e^3*control* , these situations are modeled by **sub-ideal value transfers** [14]. These are graphically represented by dashed arrows, and can indicate different risks: e.g. that actors do not pay for goods, do not obtain the goods, or obtain wrong goods. For example, Fig. 2 models a situation that the seller does not pay VAT. 'L' is a **liability token** [14], assigned to the actor who is responsible for the sub-ideal value transfer , the seller in this case.

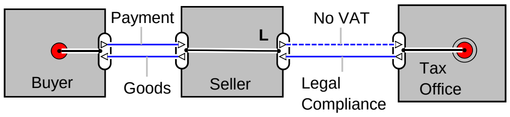


Figure 2. Example of an sub-ideal e3-control model of a purchase with tax payment

Using an e^3*control* model, we can see the sub-ideal behavior in a network as control problem, for which we have to design one or more controls.

2.2.3 Step 3: Reduce *sub-ideality* by adding inter-organizational controls

In this step we model control mechanisms that *reduce* the control problem. Hardly any control mechanism can *remove* a control problem completely. A combination of mechanisms, so-called 'control mix', is usually required [22].

For example, in Fig. 3 the control mechanism of fining is introduced. In case the seller does not pay taxes, he is charged with a high fine. The fine is modeled as a value object, transferred from the seller to the tax office. As can be seen by the dashed transfer, the model is still sub-ideal, but at least the Tax Office receives adequate compensation if the seller behaves sub-ideally.

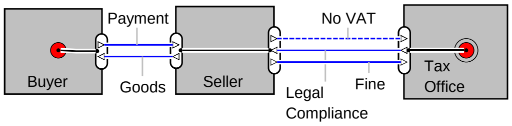


Figure 3. Example of an e^3*control* solution model of a purchase with tax payment

3 Control patterns

The design process in Sec. 2 is fairly general and, to our experience, requires quite some design knowledge on (well accepted) control problems and solutions. To increase the usability of e^3*control* , it is therefore important to bring in *accepted* knowledge about control problems and solutions. We do it by *inter-organizational* control patterns (cf. [1]). These patterns and their use is the main contribution of this paper.

3.1 Elicitation and representation of control patterns

3.1.1 Elicitation method

Pattern development usually consists of the *identification*, *collection* and *codification* of existing knowledge [7]. The PattCaR method developed by [23], suggests more specific guidelines for patterns elicitation: (1) analysis of the *domain* and *context* of the patterns, (2) definition of a *vocabulary*, (3) a thorough domain analysis and extraction of *patterns candidates*, (4) a collection of several examples of each *pattern candidate*, (5) *encoding* of patterns by modeling the examples and performing a commonality-variability analysis, and (6) a description of *relations* between patterns.

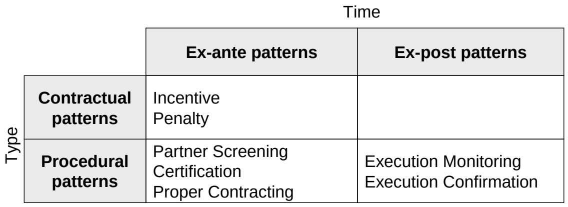
Due to space restrictions, we present the result of the domain analysis, which includes first a literature review and a series of case studies. Then we present two patterns of our pattern library (see Fig. 4). Finally, we present a case study to demonstrate the application of the control patterns.

3.1.2 Theoretical framework

A classical economics theory of business controls is *agency theory* (see [6] for a survey). This theory focuses on a relationship between two parties: a *principal*, who delegates some activity to an *agent*. The theory argues that if (1) the principal and the agent are utility maximizers with bounded rationality and (2) there is an information asymmetry in favor of the agent, the *agent may behave opportunistically*. The agency theory distinguishes two types of opportunistic behavior, caused by information asymmetry. The first type is caused by *hidden information*; a principal can not be sure that an agent accurately presents his ability to do the work for the principal (consider a producer who has better information about the product he makes than someone who wants to buy the product). The hidden information problem arises *ex-ante*, thus before a contract between the principal and the agent is settled. The accepted control mechanism against hidden information is *screening* [18] (the producer may screen trustworthiness of the potential buyer by visiting him or collecting information about him). In our library, the **Partner Screening** pattern represents this screening mechanism. The **Certification** pattern represents a case of screening, but now utilizing certification or guarantees provided by a certification authority. This is also referred in the literature as *signaling* [18].

The second type of opportunistic behavior is caused by *hidden action*; here the principal can not be sure whether the agent did his work according to the contract or not (a producer uses low quality components to produce a good; as a result, the quality of the delivered good is lower than the quality agreed in the contract). The control mechanisms against the hidden action problem are *monitoring* of agent and creation of *incentives* [6]. The hidden action problem arises *ex-post*, thus after the contract is settled, however the contracts on incentives and penalties are agreed on ex-ante. In our library, the **Execution Monitoring** pattern represents a control of agent's activities by examining the activities and/or thier outputs. The **Incentive** and **Penalty** patterns describe contractual controls, by giving the agent positive or negative incentives. A penalty is a negative incentive, as in the previous example with the tax office.

Finally, the two pattern **Proper Contracting** and **Execution Confirmation** refer to creation of proper evidence (1) about commitments made between the principal and the agent, and (2) about execution of obligations by the principal. This evidence is needed to avoid that (1) agent refuses to acknowledge that he made a commitment to a principal and (2) that the agent refuses to acknowledge that the principal executed his commitments. These two controls are discussed in the control literature [3].



	Ex-ante patterns	Ex-post patterns
Contractual patterns	Incentive Penalty	
Procedural patterns	Partner Screening Certification Proper Contracting	Execution Monitoring Execution Confirmation

Figure 4. Patterns

Controls can be subdivided into contractual obligations, called *contractual controls*, and formal organizational mechanisms for cooperation, called *procedural controls* [21]. Incentive and Penalty patterns describe contractual controls, whereas other patterns describe procedural controls.

3.1.3 Case studies

In addition to the literature review, the elicitation and validation of usability of patterns was done through a series of case studies. We describe them shortly below.

- **Beer Living Lab.** The case is about an excise collection procedure inside and outside the EU. This case contains the patterns Execution Monitoring, Partner Screening Certification, and includes multiple situations when activities by a principal or an agent are delegated to other trusted parties. The patterns were able to handle this complexity [15].
- **Dutch health care services.** The case is about processes in Dutch health care system. It contains the patterns Execution Monitoring and Certification and provides a test of patterns for a non-profit sector [16].
- **International trade.** The case is about a bill of lading procedure in international trade. It contains the patterns Execution Monitoring, Proper Contracting and Execution Confirmation. It demonstrates the application of patterns in a complex situation when control mechanisms in a network are conflicting [17].
- **Internet Radio.** The case about an Internet service of free radio broadcasts. It contains, by applying the Execution Monitoring pattern, a mechanism for controlling how many listeners the radio station has, using data collected from distributed listeners [13].

3.1.4 Representation of control patterns

Traditionally, a pattern has about the following structure: *name*, *context*, *problem*, *solutions* [9]. Since in the context of controls, control mechanisms are solutions for control problems, we define a *control pattern* as a *description of generic and re-usable control mechanism for a recurring control problem.*

Table 1. Pattern Template

Textual description	
Name	< name of the pattern>
Context	<description of the context>
Problem	<description of the problem>
Solution	<description of the solution>
Graphical description	
Value View	**Process View**
<context>	<context>
<problem>	<problem>
<solution>	<solution>

To represent contractual patterns, we use e^3*value* tp specify value models, as we did in the examples in Fig. 3, which is actually an application of the Penalty pattern. However, to represent procedural patterns, such as Execution Monitoring, the value perspective is not sufficient. Many control aspects can only be modeled at a business process level, by representing operational activates, objects and relations between them. However, a change in processes may result in a change in the corresponding value model. That is why we consider such patterns still as *value* control patterns. So, a control pattern should have two viewpoints: a value viewpoint (represented by e^3*value*) and a process viewpoint (represented by UML-activity diagrams [8]). A template for control patterns can be found in Table 1.

Vocabulary. We use the following terminology[1] to describe a control pattern. There are two actors, a **primary actor** and a **counter actor**. From a value perspective, the primary and counter actors exchange value objects: the primary actor transfers a **primary value object** (PO) to the counter actor, and the counter actor transfers a **counter value object** (CO) in return. From a process perspective, the exchange of PO corresponds to execution of a **primary activity**, and the exchange of CO corresponds to execution of the **counter activity**. These activities can also be collections of multiple operating activities, as defined in UML [8].

Sub-ideal behavior and, consequently, sub-ideal transfers are defined from the point of view of the primary actor, who is the *principal*. Sub-ideal behavior is executed by the counter actor, who is the *agent*. The primary actor expects the counter actor to behave sub-ideally (in terms of the primary actor) with respect to the execution of the counter activity. The result of this opportunistic behavior is a sub-ideal transfer of the CO. Obviously, actors can all play the role of principal or agent, depending on the perspective taken.

Furthermore, based on [3, 4, 22], we have also developed a vocabulary of **control activities** and **control principles**, which form the building blocks for control mechanisms. The activities include e.g. **verify**, **witness**, **testify**, and **authorize**. The control principles are normative rules of relations between activities, objects and actors [4]. Examples of such rules can be found in this paper e.g. as part of the pattern Execution Monitoring. Here, *segregation of duties* requires the party who executes a verification activity to be *independent* and *socially detached* from the party who executes the activity being verified. Also, the *ordering* of activities is motivated by control principles. For more details on control principles see [15].

Below we describe two control patterns that we use in the case study of this paper. Other patterns can be found in [15, 17] or on http://www.kartseva.nl/research/patterns.html.

3.2 Penalty pattern

Name Penalty

Context Two actors (see Fig. 5), a primary actor and a counter actor, exchanging a primary value object PO and a counter value object CO.

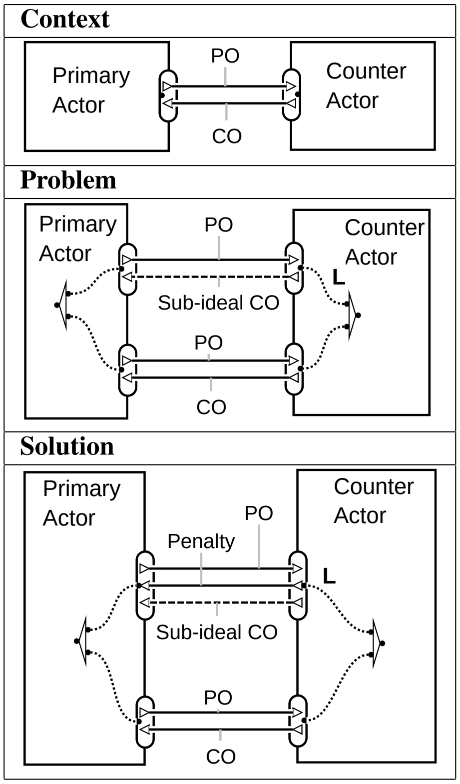


Figure 5. Penalty pattern

Problem The counter actor may behave ideally or sub-ideally. In case of ideal behavior, the transfers are as in the context model. The counter actor transfers the counter value object CO, and gets in return the primary value object PO. In case of sub-ideal behavior, a sub-ideal counter value object, marked with dashed line, is transferred. A liability token **L** is then assigned to the counter actor, to indicate that he is responsible for the sub-ideal transfer. In the sub-ideal transfer, the primary value object PO is also considered to be ideal.

Solution The solution prevents sub-ideal behavior of the counter actor by ensuring that the total value experienced by the counter actor as received from executing the sub-ideal path, is *lower* than the total value as received from the ideal path. The counter actor pays a *penalty* if he behaves sub-ideally. In Fig. 5 the penalty is modeled as a a value object $Penalty$, bundled with the *Sub-ideal CO* and transferred from the counter actor to the primary actor.

3.3 Execution Monitoring pattern

Name Execution Monitoring

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[1] The terminology is inspired by [3]

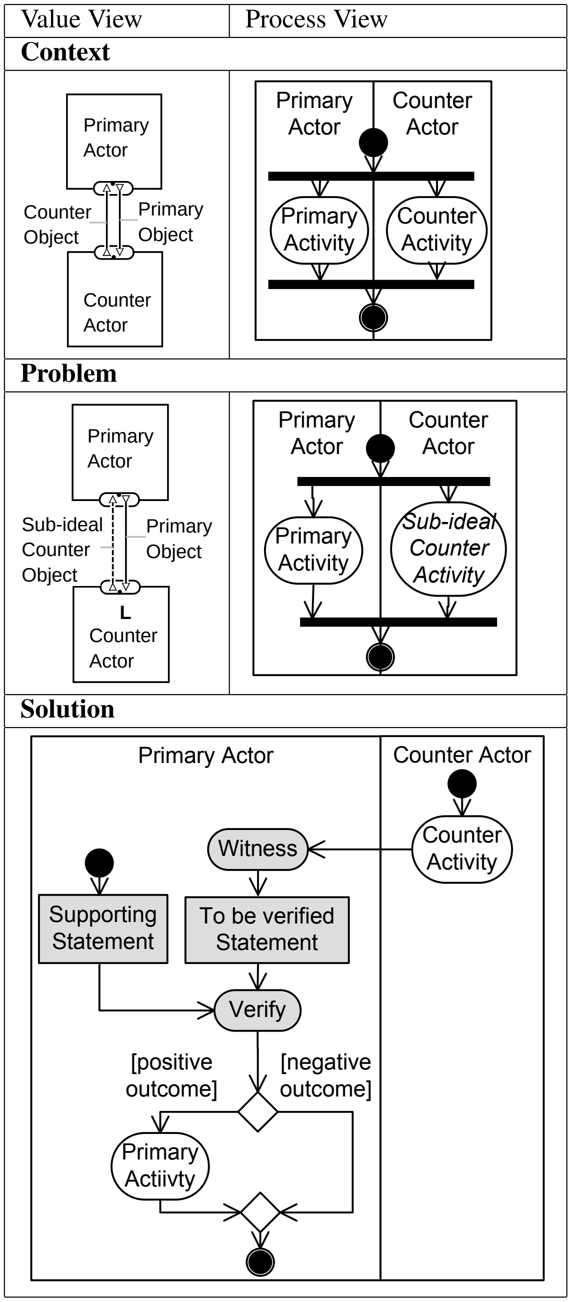

Figure 6. Monitoring pattern

Context A primary actor and a counter actor agreed to execute a primary activity and a counter activity, as a result, they exchange value objects PO and CO (see Fig. 6). Agreements about the execution and conditions of the counter activity are in a so-called **supporting statement**.

Problem The counter actor executes the counter activity sub-ideally, so that it does not comply with the supporting statement. On the value level, this problem is modeled with a sub-ideal transfer of CO. On the process level, the problem is modeled with a sub-ideal execution of the counter activity.

Solution The primary actor must verify if the counter activity complies with the agreements in the supporting statement. Only if compliance is established, the primary actor should execute the primary activity [3]. In addition, the verification should be based on witnessing of the counter activity by the primary actor or his trusted party [3]. The trusted party is a party who is independent and socially detached from the counter actor [4].

In the process model this solution is modeled as follows. The primary actor executes an activity **witness**, which has as input the outcome of the counter activity, and an information about the counter activity as its output, represented with a **to-be-verified statement**. The two statements are taken as an input in the **verify** activity, which reconciles information in these two statements. The primary activity is executed only if the statements are consistent with each other (see **positive outcome**). The value perspective only changes if we consider delegation of some activity. In Fig. 6 we only show a situation without delegation, so the value model of the solution is the same as in the context.

4 Case study: Renewable Energy in the UK

4.1 Renewable Energy in the UK

Interesting complicated control problems can be found in a renewable electricity sector. In order to comply with international environmental agreements, such as the Kyoto protocol, governments must ensure that a sufficient amount of electricity is produced with renewable technologies, such as wind turbines, photovoltaic panels, hydro generators. These so-called 'green' technologies require high initial investments, and, therefore, the price of the green electricity is higher than the price of electricity produced in conventional way. Consequently, a government regulation is needed to guarantee that electricity companies will use these commercially less attractive technologies.

In the United Kingdom the Renewables Obligation (RO) regulation is designed to stimulate generation of green elec-

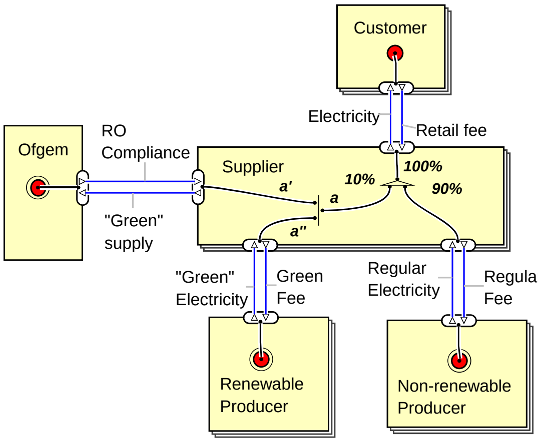

Figure 7. Ideal e3-control model of the ROC business model

tricity. The RO law places an obligation on licensed electricity **suppliers** in the UK to source an increasing proportion of electricity from renewable sources [20]. In 2006/07 it is 6.7% (2.6% in Northern Ireland). Suppliers meet their obligations by presenting Renewable Obligation Certificates (ROCs). ROCs can be acquired by suppliers from **producers** of green electricity. Initially ROCs are issued to the green producers by a government agency, the Office of Gas and Electricity Markets (**Ofgem**). One ROC is issued for each Mega Watt/hour (MWh) of eligible renewable output. ROCs are issued into a ROC Register, maintained by Ofgem. If suppliers do not have sufficient ROCs to cover their obligation, they must make a payment into the buy-out fund. The buy-out price is a fixed price per MWh shortfall and is adjusted in line with the Retail Prices Index each year. The buy-out fund is paid back to suppliers in proportion to how many ROCs they have presented. In this case study we apply the e^3*control* methodology and the patterns to describe controls the RO model.

4.2 Step 1: State the *ideal* networked value constellation using an e^3*value* model

Fig. 7 presents an ideal value model for the renewable energy case. In addition to the introduced actors **supplier**, **producer** and **Ofgem**, we have a market segment of **customers**, which represents the final consumers of electricity in the UK. We have **renewable producers**, defined by regulation as accredited renewable generators (for an exact definition see [20]), and **non-renewable producers**, who are any other generators (thus, not accredited for renewable production).

In order to satisfy a customer's need for electricity, the supplier provides electricity and obtains a retail fee in return for that[2]. The supplier has a choice (as denoted by the OR-fork, represented by the triangle in the segment of the supplier). He may decide to obtain electricity from a non-renewable producer and pay in return a regular electricity fee. This is modeled by the transfer of value objects $RegularElectricity$ and $RegularFee$. On the other hand, the supplier can decide to buy the electricity from a renewable producer, by which he chooses the path *a* in Fig. 7. The path *a* has an AND-fork, which indicates that the supplier does two things there. First, the supplier buys $GreenElectricity$, and pays $GreenFee$, a fee calculated based on more expensive green electricity price (see path *a"*). Second, the supplier reports the supply of green electricity and receives a compliance with the RO, modeled with objects $GreenSupply$ and $ROcompliance$ accordingly.

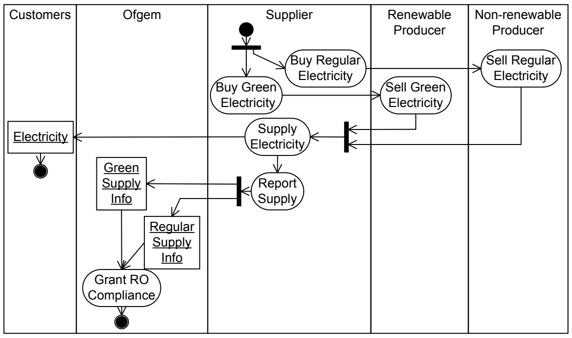

Figure 8. The process model corresponding to the value model in Fig. 7

According to the RO regulation the supplier has to obtain a certain percentage, say 10%[3], of the electricity from renewable producers. In e^3*value* terms, this means that the electricity delivered via path *a* in Fig. 7 has to account for at least 10% of the whole amount of electricity supplied.

In Fig. 8 we represent a process model that corresponds to the ideal value model in Fig. 7. Because it is an ideal model, Ofgem gets the correct information about the amount of green and regular electricity from the suppliers. This information is transferred by the supplier's activity $ReportSupply$ in a form of objects $GreenSupplyInfo$ and $RegularSupplyInfo$. Ofgem needs to know the percentage of green supply within the total supply, so the information about both green and regular supply is needed.

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[2] In this model, the consumer buys both green and conventional electricity for the same price. However, other business models are possible, where the consumer is also charged a higher fee for green electricity and a lower fee for the conventional one.

[3] When the regulation was introduced in 2002, the limit was around 10%. Currently in 2006/07 it is 6.7% and 2.6% in Northern Ireland. In this model we assume the limit of 10%.

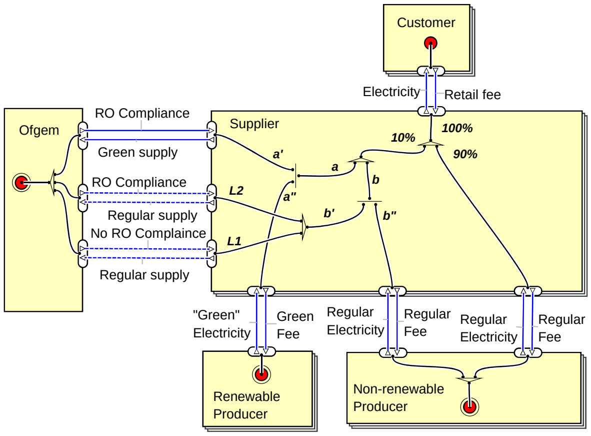

Figure 9. Sub-ideal e3-control model of the ROC business model

4.2.1 Step 2: Analyze *sub-ideality* in networked constellations using an e^3*control* model

We can identify two types of sub-ideal behavior by suppliers within the developed models. First, not every supplier complies with the renewable obligation. The suppliers that *do not comply with the RO* are considered by Ofgem as behaving sub-ideal. A sub-ideal behaving supplier buys a lower percentage of green energy than the percentage prescribed by the regulation. In this case, the RO compliance is not granted (completely). Secondly, some suppliers can **overstate** the percentage of green supply in order to obtain the RO compliance illegally. These suppliers report a higher percentage of green electricity and get the RO compliance.

We model the two controls problems in a sub-ideal value model with e^3*control* in Fig. 9. In this figure, the second OR-fork appears at the supplier and leads to two sub-paths *a* and *b*. The sub-path *a* corresponds to the ideal behavior of supplier, shown previously in Fig. 7. In the sub-path *a* the supplier buys green electricity and gets RO compliance.

The sub-path b corresponds to the two types of sub-ideal behavior. In both cases, the supplier buys $RegularElectricity$, which corresponds to the sub-path *b"*. Further, the OR-fork at the sub-path *b'* indicates two cases of sub-ideal behavior. The sub-path, marked with a liability token L1, corresponds to the situation when the supplier reports his low supply of green electricity and does not get the RO compliance. At the sub-path, marked with a liability token L2, the supplier overstates his low supply of green electricity and gets the RO compliance illegally. Both cases are marked as sub-ideal with dashed value transfers.

4.2.2 Step 3: Reduce *sub-ideality* by adding inter-organizational controls

To solve the control problems, Ofgem implements several control mechanisms, which result in the ROC certificates scheme. As we demonstrate below, these control mechanisms can be found using the patterns Penalty, Incentive and Execution Monitoring.

Although we have developed a method on how to precisely select a proper pattern for a particular control problem [15], due to space considerations we do not demonstrate the selection process. Instead, we immediately suggest what pattern to apply to solve a problem.

4.3 Applying patterns Penalty and Incentive

The prevention of the first type of sub-ideal behavior (see path L1 in Fig. 9) can be done by using controls from the penalty and incentive patterns. According to the RO regulation [20], the supplier who does not have sufficient green supply to cover their obligation, must make a payment into the **buy-out fund**. The buy-out fund payment can be modeled as a penalty using the penalty pattern.

To apply the penalty pattern to this case, we first need to match the sub-ideal value model in Fig. 9 to the problem model of the penalty pattern in Fig. 5. Thus, *Supplier* is the counter actor, because he behaves sub-ideally and so has the liability tokens. Consequently, *Ofgem* is a primary actor. The value objects $ROcompliance$ and $GreenSupply$ exchanged between Ofgem and Supplier are ideal primary and ideal counter value objects; $NoROCompliance$ and $RegularSupply$ at the path L2 are sub-ideal primary and sub-ideal counter value objects.

According to the solution of the **penalty pattern**, we must add a new value transfer $Penalty$ to the transfer of $NoROCompliance$ and $RegularSupply$, and change $NoROCompliance$ to $ROCompliance$. The result is presented in Fig. 10, where the penalty is presented by a value object *Buy-out Fee*. Thus, at the sub-ideal path *b*, where the supplier does not supply enough green electricity, he is obliged to pay a buy-out fee in order to cover the RO.

In addition, the pot with buy-out funds is paid back to suppliers in proportion to how many green electricity they have purchased [20]. This can be modeled as an **incentive** to suppliers to purchase the green energy. In short, the incentive pattern is the opposite of the penalty pattern. The incentive is modeled as an incoming value object to the sub-ideal actor in the ideal value transfer. In Fig. 10, the incentive value object is called *Buy-Out Fund* and is added to the transfer of $GreenSupply$ and $ROCompliance$.

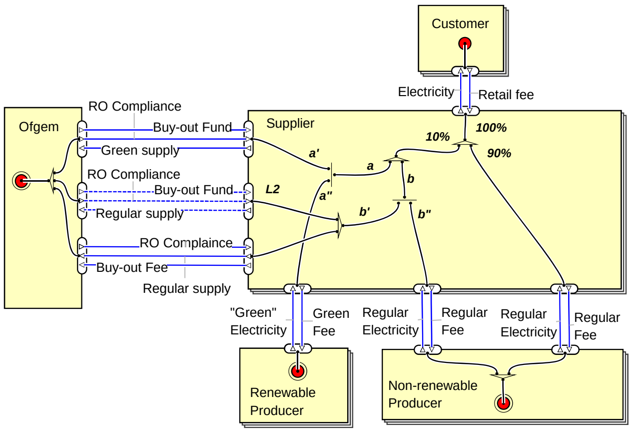

Figure 10. Penalties and incentives in the ROC business model

4.4 Applying the Execution Monitoring pattern

The second control problem, when the suppliers overstate their green supply (see path L2 in Fig. 9), is of procedural nature and should be solved by a procedural pattern. The controls of the pattern Execution Monitoring are suitable to prevent the problem.

We match the sub-ideal value model in Fig. 9 to the problem model of Execution Monitoring pattern in Fig. 6. As before, Ofgem is a primary actor, and Supplier is a counter actor and the value objects $ROcompliance$ and $GreenSupply$ exchanged between Ofgem and Supplier are ideal primary and counter value objects. The sub-ideal primary and counter value objects are $ROcompliance$ and $RegularSupply$, corresponding to the path L2 in Fig. 9.

From the process model in Fig. 8 we identify the primary and counter activities. The primary activity is an activity ”Grant RO Compliance” of Ofgem, that corresponds to the transfer of $ROcompliance$. The counter activity is the transfer of ”Buy Green Electricity” of supplier that corresponds to the transfer of $GreenSupply$. In the sub-ideal case, in Fig. 8 the supplier executes an activity ”Buy Regular Electricity” instead of ”Buy Green Electricity”.

According to the solution of the pattern Execution Monitoring (see Fig. 6), we need to add a witness activity to Ofgem or his **trusted party**. The witness activity should produce a to-be-verified statement, which is then verified by a verify activity against a supporting statement. Within the context of this case, the witness activity must observe the buying of the green electricity by the supplier, the to-be-verified statement must provide information about the amount of bought green electricity, and the supporting statement is an RO regulation about the required percentage of green electricity (which we assume is 10%).

After we apply the pattern to the ideal process model in Fig. 8, we obtain the model with controls in Fig. 11. The elements added as a result of applying the pattern are shown in gray. The renewable producer plays the role of the trusted party. Ofgem, as an administrative government organization, is not able to observe the supply of the electricity and delegates this to a renewable producer. So, we add an activity Witness Green Supply to Renewable Producer and an activity Verify Compliance to Ofgem. According to the pattern, the activity Witness Green Supply must be executed after or at the same time as Buy Green Electricity activity and before Verify Compliance activity. The outcome of the witness activity contains information about how much electricity was bought by which supplier and represents the to-be-verified statement. This is, in fact, the ROC registry. It is fed into the activity Verify Compliance, which compares if the ROC registry of the particular supplier constitutes 10% of his whole supply, modeled with the supporting document is the object $RO\ Legislation$. In addition, the information about the regular supply is required to calculate the percentage of the green supply. This is modeled by the object $RegularSuipplyInfo$, as in the ideal process model in Fig. 8.

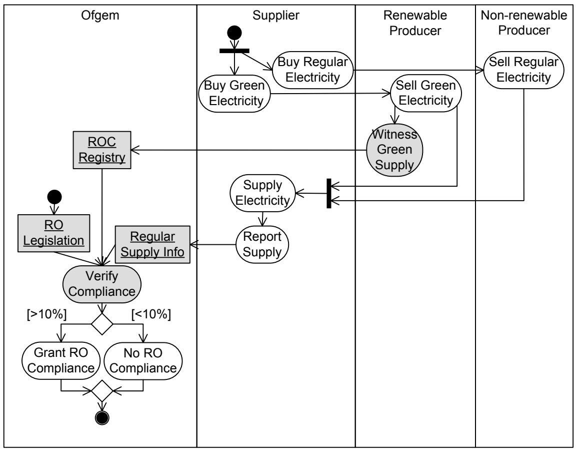

Figure 11. ROC model suggested by the pattern Monitoring

This model represents a part of the actual process of ROCs exchange, which demonstrates that the patterns are usable to design solutions for real-life control problems. In addition, in real life, the ROCs can also be traded among suppliers, which requires additional controls. These control can also be modeled with the pattern Execution Monitoring.

5 Conclusions

In this paper, we have presented two patterns for the value-based design of inter-organizational controls. Additionally, we have provided pointers to a library containing more of such patterns. The proposed patterns take an explicit *economic value* perspective on the control problem: it is important to understand first the valuable objects to be safeguarded, before embarking on a design track for controls ensuring proper transfer of objects. Furthermore, we learned that implementation of controls can spawn-off new commercial services (e.g. certification or witnessing authorities), which influence the business model of networked enterprizes, and therefore are important to know.

We have contributed a structure for stating control patterns in terms of ideal value&activity models, sub-ideal value&activity models representing the fraud, and possible solutions expressed using similar model types. The patterns themselves stem from two sources: (1) accepted theory on the principal-agent relations, accounting, and auditing, and (2) four industrial case studies we have performed to design inter-organizational controls.

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