Supporting the design of service contracts with interaction models

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Abstract: A service contract typically specifies the service level, *i.e.*, the quality parameters of the service to be performed. In addition to this static part, there is also the need to specify the business interactions required to achieve the service level, which can be seen as the dynamic part of the contract. We suggest a procedure to derive both parts of the service contract from the same model of the interactions between service provider and client. This ensures the alignment of both parts and adds richer, behavioural semantics to the contract. We show the feasibility of the approach in a case study with a logistics service provider and its clients.

Keywords: Business Services Network; BSN; Service-Oriented Architecture; SOA; service contract; business interaction; Dynamic Essential Modelling of Organization; DEMO.

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1 Introduction

A Service-Oriented Architecture (SOA) allows a service consumer to make use of a service that is offered by a service provider. A third component, the service broker, makes sure that requested and provided services are matched. A reference model for such an architecture has been suggested by the Organization for the Advancement of Structured Information Standards (OASIS) (MacKenzie *et al*., 2006). Web services (Arsanjani *et al*., 2003; Tsalgatidou and Pilioura, 2002) and their networks can be seen as an implementation of SOA (Kreger, 2001; Myerson, 2002). There, focus is on the integration of software components, *i.e.*, applications (Samtani and Sadhwani, 2002a), so that the issue of integration with the surrounding business processes remains (Leymann *et al*., 2002; Papazoglou, 2003; Samtani and Sadhwani, 2002b). Business Services Networks (BSNs) (Gagnon and Hung, 2005) resolve that issue by going from web services to business services. As Tenenbaum and Khare (2005, p.52) state:

> "Ultimately, our central claim is that large-grain reuse via BSNs will actually become easier than fine-grained Enterprise Application Integration (EAI) approaches. Rather than communicating at the level of abstraction embodied by today's software components, BSNs should aspire to interoperate at the scale of business processes – because firm boundaries are much larger, and more stable, than object interfaces."

Such business services can also include non-IT services, such as logistics.

From a theoretical perspective, BSNs can contribute to a decrease in transaction costs (Coase, 1937; Klein *et al*., 1978; Williamson, 1975; 1981; 1985), as well as agency-related costs (Wilson, 1968; Alchian and Demsetz, 1972; Ross, 1973; Jensen and Meckling, 1976). This is achieved by combining the benefits of market-based coordination with those of internal hierarchies (Malone *et al*., 1987; Clemons *et al*., 1993; Holland and Lockett, 1997; Tenenbaum and Khare, 2005). Coordination is therefore an important issue in BSNs.

In SOA, coordination is represented by two concepts of the reference model: interaction and contract. Both concepts are closely related because the contract regulates the interaction between provider and consumer. It is a (formal) representation of the mutual obligations that the parties have towards each other. It sets minimum quality standards that have to be achieved. These standards are called the service level. A service-level agreement is an implementation of such a contract. Besides the quality standards, it also contains penalties for failing to reach the level and rewards for overperforming.

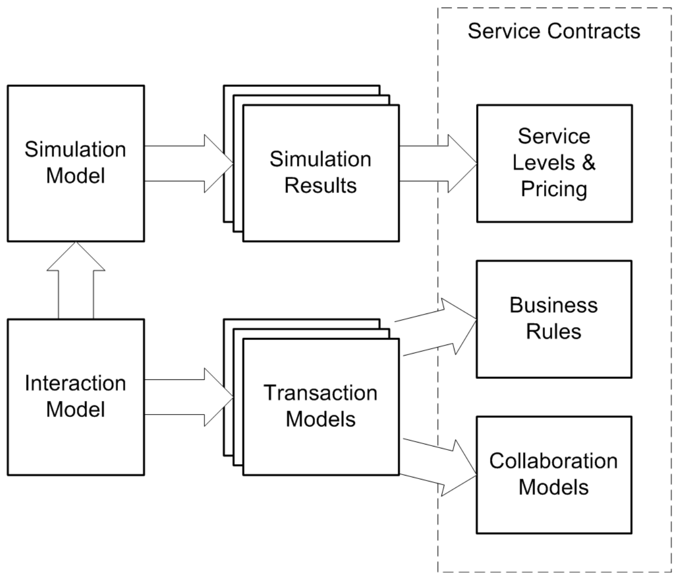
But as pointed out earlier, contract and interaction are closely related. This means that the terms in the contract determine to a certain degree both the internal (private) behaviour of each partner and their interaction, *i.e.*, their common behaviour. The interaction is, in that way, an embodiment of the contract and, vice versa, the contract governs the interaction. It is therefore necessary to incorporate the public behaviour into the contract. We call this extended contract a service contract from hereon and we suggest a procedure to support the design of such contracts.

Interaction in the SOA reference model refers mainly to the interaction with the service. But in BSNs it is more appropriate to extend this term to the business interaction between service provider and service consumer. Modelling business processes in a BSN is considered to be an important function of Business Services Management (BSM). For analysing and designing this interaction, we will make use of the Business interAction Theory (BAT) (Goldkuhl, 1996; 1998; Goldkuhl and Lind, 2004). It has been empirically validated in many projects (Lind and Goldkuhl, 1997; Melin and Goldkuhl, 1999; Axelsson *et al*., 2000; Goldkuhl and Melin, 2001; Axelsson and Segerkvist, 2001; Lind *et al*., 2003; Melin and Axelsson, 2004; Johansson and Axelsson, 2004; 2005; Haraldson and Lind, 2005) and can therefore be considered a stable framework. For the analysis and design of business interactions between service providers and service consumers, we will use Dynamic Essential Modeling of Organization (DEMO) (Dietz and Habing, 2004; Liu *et al*., 2003; Dietz, 1999). DEMO is a language that implements the principles of BAT, but it also offers interaction patterns that facilitate the development of interaction models. Another important feature of DEMO is the business service (transaction) layers that exist both in the metalanguage and as concepts in the modelling language itself.

Our analysis of the BSN will be based on the interaction model of DEMO. It describes how organisations or organisational units interact with each other. The unit of analysis is the business service (a transaction in DEMO terminology). The interaction model describes the architecture of a BSN. This can form the basis for the development of more detailed models of collaboration between members of a BSN. But in addition to this, it can also support the design of contracts regulating the cooperation, one for each provider-consumer pair. Please observe that this implies that two consumers making use of the same service might have different contracts with the provider although they will more likely be the same. As the service contracts are formulated in a rigorous language, the enforcement of the agreements is also facilitated. This implies that the costs for 'writing' and enforcing contracts, *i.e.*, the contractual costs, are reduced. These form a substantial part of the overall transaction costs (Gurbaxani and Whang, 1991). Hence, the design of service contracts supported by an interaction model can reduce transaction costs. In addition, a rigorous contract facilitates monitoring of agent behaviour, which leads to a reduction of agency-related costs.

In the section 'Service Contracts', we give an outline of the structure of such agreements. We take a closer look at three of their components, service levels and pricing, business rules and collaboration models, and show how they can be derived from the detailed description of the BSN interaction. Figure 1 depicts the overall process.

Figure 1 The design of service contracts based on an interaction model



2 A business action perspective on BSNs

At the core of the business action perspective are the Speech-Act Theory (Austin, 1962; Searle, 1969) and the Theory of Communicative Action (Habermas, 1984). The central claims of these theories are that business actions are essentially social actions and that these actions can be either communicative or material. According to this view, language is not only, and not even primarily, a medium for exchanging information but also a means of action. Uttering something is actually doing something. We can instruct, direct, request, make commitments, promise, apologise, declare marriage and the like, all by just saying a few words. Communicative actions lead to state changes in the social world. Material actions, on the other hand, involve changes in the physical world through the intervention of the actor. Business services comprise both communicative and material aspects.

In business interaction, communication is often aimed at the performance of a specific action ('getting a job done') to achieve some objective. Templates for such goal-driven conversations are the Conversation-for-Action schema (Winograd and Flores, 1986) and the Action-Workflow Loop (Medina-Mora *et al.*, 1992; Denning and Medina-Mora, 1995). They provide a stable framework for the analysis of organisations in general and BSNs in particular. More sophisticated examples of such frameworks are: DEMO (as already mentioned), Action-Based Modelling (Lehtinen and Lyytinen, 1986), Business Action Theory and SIMM (Goldkuhl and Röstlinger, 1993; Goldkuhl, 1996).

As pointed out in the introduction, we have selected DEMO as the most suitable language for modelling business interaction in a BSN. Beyond the reasons mentioned there, the richness of business interaction patterns in DEMO and the distinction of business service layers, there is also another factor that plays an important role: DEMO is formalised to a substantial degree that facilitates the development of service contracts, which are also supposed to be formal.

2.1 DEMO

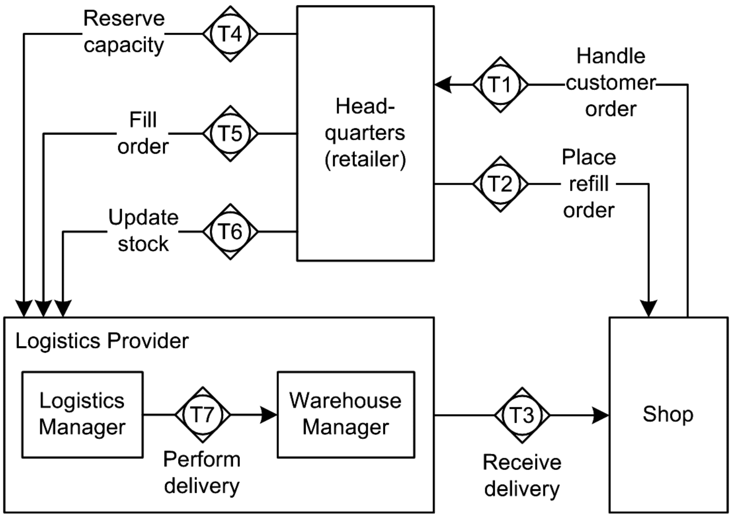
In DEMO, the structure of an organisation is understood as a network of commitments. As these commitments are the result of communication, it follows that a model of the organisation is essentially a model based on purposeful, communicative acts. In DEMO, all acts that serve the same purpose are collected in a business service (transaction) in which two roles are engaged: the initiator and the executor. Each business service is assumed to follow a certain pattern that is divided into three sequential phases and three layers. The phases are: order (O), execute (E) and result (R). The layers are: success, discussion and discourse. On the success layer, the phases are structured as follows. In the order phase, the contract is negotiated. This typically involves a request made by the initiator and a promise by the executor to carry out the request. In the next phase, the contract is executed, which involves factual changes in the object world (as opposed to the intersubject world of communication). Finally, in the result phase, the executor states that the agreed result has been achieved and the initiator accepts this fact. If anything goes wrong on the success layer, the participants can decide to move to the discussion or discourse layer. For details on these layers, see van Reijswoud (1996).

The following section describes one of DEMO's models, the interaction model, which will serve as a basis for deriving the business service models, which in turn lead us to the business rules and the collaboration models.

2.2 DEMO's interaction model

The interaction model shows actors and business services. The actors are roles that are enacted by a person, an organisational unit or a whole organisation. Figure 2 shows the interaction model of our case. The main actors are the Logistics Provider, the Headquarters of the retailer and the Shop. The latter two maintain a very close, franchise-like relationship but are nevertheless organisations in their own rights.

Figure 2 Interaction model



A business service is represented by a diamond with an enscribed circle that contains the number of the business service. An undirected arc connects it with the initiator, an arrow points from it to the executor. In Figure 2 we have added the name of the business service, which coincides with that of the productive action, to enhance readability. This is not a feature of the original DEMO language. Figure 2 describes the process of capacity reservation and order handling among these organisations. It starts when Headquarters reserve capacity for handling a certain amount of ordered items in advance of the actual order (T4). The Logistics Provider (LogPro) allocates staff and space so that the reserved capacity can be provided at the time the respective order arrives. But the capacity required by the order might actually be higher or lower than the one that was reserved.

The product assortment consists of basic-range products and seasonal products. The latter are distributed according to turnover quota and are not part of the order process. Orders for basic-range products can be initiated either by the Headquarters or by the Shop. The former happens when the Shop is running low on certain products. The Headquarters will, in such a case, suggest to the Shop to place a refill order (T2). For this purpose, they send an order proposal containing the products in question which, after possible changes and/or additions, is returned. If customers ask for specific products, the Shop can also place a so-called customer order (T1). The Headquarters will forward both types of orders to LogPro (T5). The delivery to the Shop will then be performed by LogPro (internal business service T7), which includes picking items, packing them and handing them over to the carrier. The actual delivery is mostly a material action. In the interaction model, we represent the coordinative part of it, namely the Shop receiving the delivery (T3). This consists of the arrival of the goods and a confirmation. The arrival of the goods is a material action, which also has a communicative function: Through it, LogPro states that they have performed the delivery and thereby fulfilled their obligation. The confirmation can be accompanied by a complaint if items are missing or wrong ones have been sent.

Periodically, the Headquarters will also ask for an update of the stock (T6). This is necessary because they run their own warehouse management system, which is not integrated with the one of LogPro. The next section describes how the business service models can be derived from the interaction model. This is an intermediate step towards the two dynamic parts that make up the service contracts, *i.e.*, the business rules and the collaboration models.

2.3 Business service models

Much of the detailed behaviour that constitutes a business process is hidden inside each business service. For the specification of the service contracts, this has to be brought to light because it constitutes the content of the business rules and the collaboration models. A business service in DEMO is made up of a number of communicative acts and a productive action, which follow a certain pattern. This pattern is not a rigid template that claims to fit every business service. It is rather a guideline that describes a common interaction structure that can help us in analysing a particular situation. In some cases, it will describe the situation fairly accurately; in others, we might have to revise it or even develop a new one that is specific to that particular situation. For example, BAT suggests to split the order phase into a contact establishment and proposal phase and a contractual or commitment phase. BAT also introduces two new phases at the beginning of each transaction: Business prerequisites phase and exposure and contact search phase.

The pattern consists of the phases mentioned above: order, execute and result. The actagenic conversation (O phase) has at least two elements: a request and a promise (see Figure 3) but longer negotiations (including a failure) are possible. If an agreement was reached in the order phase, the productive action (E phase) is executed and the factagenic conversation (R phase) is entered. As a minimum, this can consist of the communicative acts, state and accept. Figure 3 summarises these steps, which are performed in the order that is indicated by the leading numbers. For the actors, we use the same notation as in the interaction model. A communicative act is represented by a circle containing the number of the respective business service. An arrow goes from the performer via the circle to the addressee. The performer is the one who makes the utterance, the addressee is the 'listener'. The arrow is annotated by the name of the communicative act, which can be preceded by a sequence number. A productive action is represented by a diamond containing the number of the respective transition. The arrow starts and ends at the executor. A model that contains only actors, communicative acts and productive actions is called a communicative model. A communicative model that contains only actions and actors belonging to one business service is called a business service model.

Figure 3 Communicative model of a business service (business service model of T1)

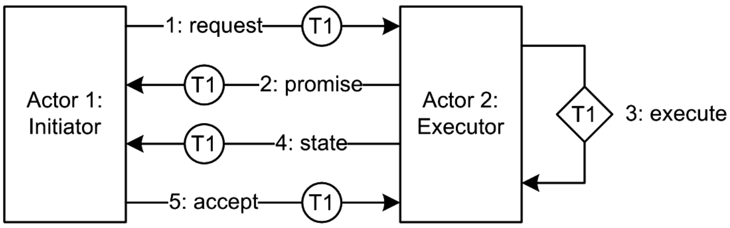
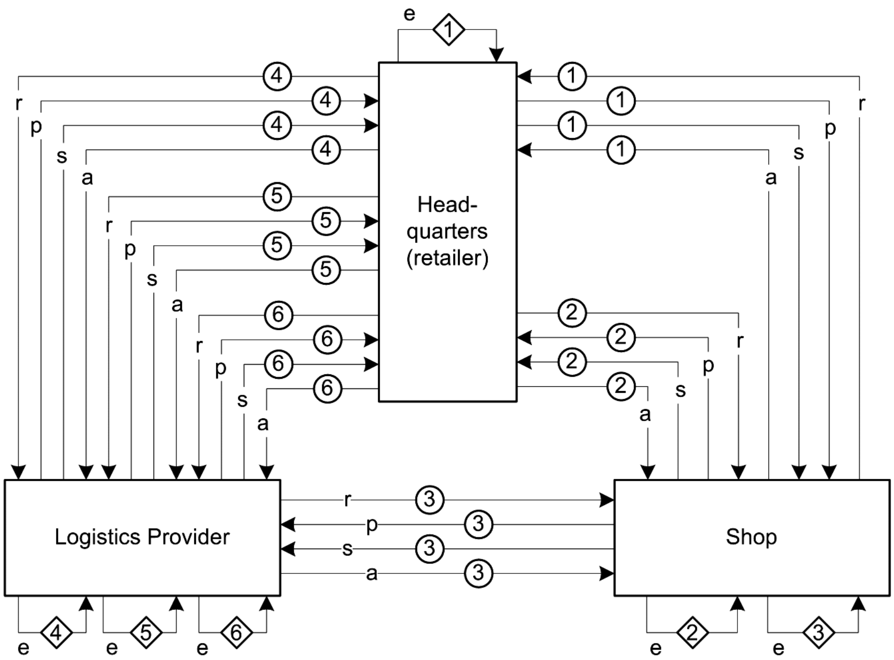


Figure 4 shows the complete, minimum communicative model of the interaction model in Figure 2. As communicative models can be very complex, for realistic cases we will usually refer to a set of business service models instead. The following section shows how these can support the development of service contracts in general and the business rules and collaboration models in particular. But first, we describe the development of the simulation model and its role in designing the static part of the service contracts, service levels and pricing.

Figure 4 Complete communicative model of the interactions



3 Simulation model and results

Service contracts have to specify service levels and pricing that can be seen as static parameters, which control the interaction between the trading partners. Examples for such parameters are pricing, terms of delivery, terms of payment, and so on. Determining reasonable values for these parameters is difficult because they depend heavily on characteristics of the interaction. This is particularly true when companies engage in a cooperation for the first time and therefore lack prior experience. Let us consider, for example, the pricing of a logistics service, *e.g.*, the handling of one unit of the customer's product. How much we charge for that depends, among other things, on how much it costs us to deliver this service, which in turn depends on the time it takes, the number of workers that are involved, resources that are used, *etc*. One way of assessing the complex interaction of these factors is to simulate the respective business process. The usefulness of business process simulation has been studied thoroughly (Giaglis *et al.*, 1999; Hlupic and Robinson, 1998; Paul *et al.*, 1999; Paul and Serrano, 2003; 2004; Weyland and Engiles, 2003), particularly in an interorganisational context (Chandra *et al.*, 2000; Giaglis *et al.*, 1996; 1997).

A simulation model is an abstracted, formal description of some real or imagined system. A simulation is an enactment of such a model that allows us:

- to observe the potential behaviour of a system that does not (yet) exist
- to observe the (potential) behaviour of an existing system at a much faster pace and at lower costs than that of the real system and without disturbing it.

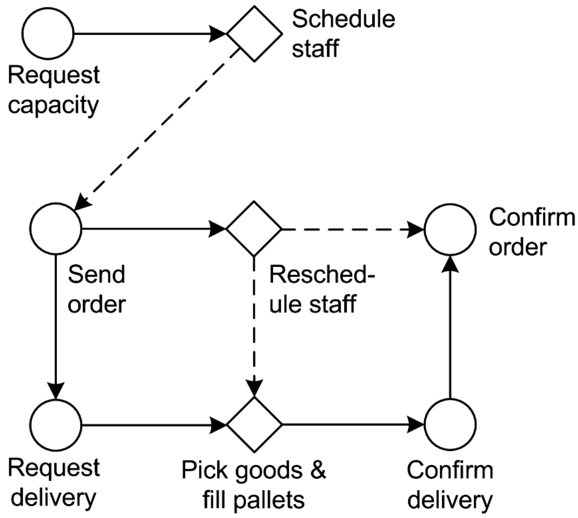
If an appropriate abstraction is chosen, the results of the simulation will represent a fair approximation of the behaviour of the real system (or the imagined system if it was built). With its help, we can determine the performance characteristics of the business process. This data can then be used to support the design of the service-level parts of the service-contracts. For the development of the simulation model, we use the approach described in Rittgen (2005). It is based on a business action model of the business process and proceeds in three steps that involve the design of complementing views:

1 designing the business process view
2 designing the resource view
3 designing the simulation model.

The first step involves the design of a flow-like view on the process that excludes the actors in favour of a more precise description of the execution logic. In the second step, we develop a view that tells us which resources are required by each action and the final step results in the simulation model, which is written in Simulation in Python (SimPy). To give the reader an idea of how this works, Steps 1 and 2 are shown in detail in the following sections. As an example, we use the pricing of product handling. This issue was given highest priority by both corporate partners in our project. We assumed that the costs of handling a product unit will play an important role in determining the price. We therefore took a closer look at business service T7, Perform delivery, and the associated business services T4, Reserve capacity, and T5, Fill order (see Figure 2).

When decomposing the business services into communicative acts and productive actions, we get the process view as shown in Figure 5. The business process starts with a request communicative act for a certain capacity, which is then used to schedule the warehouse staff accordingly (target action). Note that the promise part of the actagenic conversation is omitted because the business rules force the logistics provider to accept each request (see next section). After that, the availability of the capacity is confirmed (communicative act: state). Owing to the business rules in the service contracts (see next section), we can omit the communicative acts 'promise' and 'accept' in this and later business services. The next step in the process is the order that is sent by the customer. Observe that this action is not caused by the confirmation of the capacity because the customer might decide not to make use of the capacity and not send an order. Hence, there is no causal relation. On the other hand, the order cannot be sent without prior reservation of capacity, which makes the relation conditional (dashed arrow).

Figure 5 The process view of the interaction model

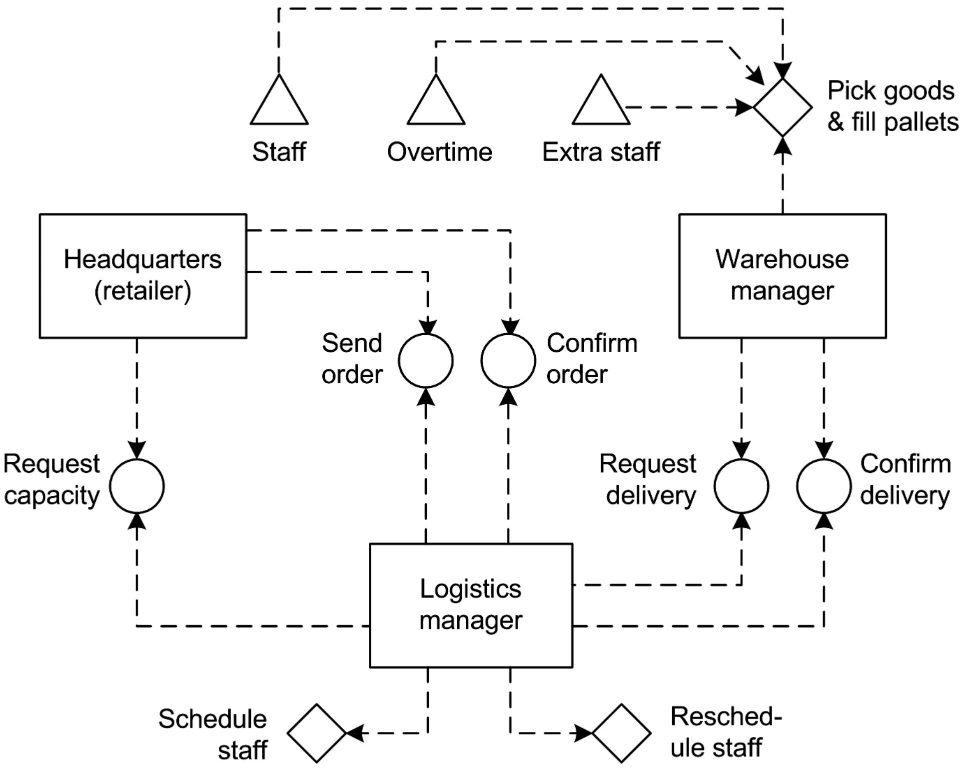


The information in the order is then used to reschedule the staff depending on the actual package load. This might involve that the outbound staff be required to do extra hours or that inbound staff be reassigned. At the same time, the delivery is requested but this cannot be done before the staff for this task is rescheduled, so that sufficient staff is available. The goods are then picked from the respective shelves and each pallet is filled with the goods destined for that particular shop. When this has been done, the pallets are picked up by the forwarder and the delivery is confirmed. This allows us to also confirm the completion of the whole order.

The work described so far was part of the initial business analysis where we also identified problems and goals. One of the most pressing problems (from the point of view of the logistics provider) was related to the discrepancies between planned and actual capacities so we suggested to do a simulation of the relevant parts of the overall process to determine how these deviations affect transaction costs. To do so, we have to complement the business process view with a resource view (Step 2) to get a clearer picture of the use of resources by the actions in the process. The result is shown in Figure 6. It contains information than can be derived directly from the other views and also some information that is new.

The resource view shows the actors and objects that are involved in each action. We assume that an actor who is engaged in an action cannot perform another action at the same time. Most of the information contained in Figure 6 can be derived from the action and process views (Figures 2 and 5, respectively) in the following way: For each action in the process view, find the corresponding business service in the action view and from there the actors involved (initiator and executor). These are the resources of the respective communicative act. The initiator becomes the performer of the request-and-accept acts and the addressee of the promise-and-state acts. Likewise, the executor will be the performer of the promise-and-state acts and the addressee of the request-and-accept acts. If the action is productive, we drop the initiator and record only the executor as a resource.

Figure 6 The resource view of the interaction model



In the example of Figure 6, this procedure yields an almost complete diagram with only three resources missing. These concern the action ‘Pick goods & fill pallets’ that requires additional resources: the scheduled staff, extra staff that might be called in and overtime of the scheduled staff. The use of these resources is associated with certain costs. The time for filling the pallets depends on the actual number of packing units to be handled, the number of available staff (including extra staff), the overtime and the time required for handling a unit. The latter is assumed to be normally distributed with given μ and σ. Packing units that cannot be handled during the week in question have to be treated in the following week, which leads to delays and further overtime. The time for (re)scheduling is also normally distributed with given μ and σ. All other actions are assumed to require a negligible time.

A run of the resulting simulation model yielded results for a full year (52 weeks), the first six of which are shown in Table 1.

Table 1 Excerpts from the simulation results

Reserved capacity	*Actual units*	*Deviation (%)*	*Staff*	*Extra staff*	*Overtime*	*Handled units*	*Total costs (€)*	*Costs per unit (€)*
4841	7366	52	10	4	29,28	7366	11.385,60	1,55
5099	4494	–12	10	0	–40,48	4494	6.000,00	1,34
4684	4957	6	9	0	36,56	4957	6.131,20	1,24
2203	1179	–46	4	0	–65,68	1179	2.400,00	2,04
5374	7817	45	11	3	65,36	7817	11.507,20	1,47
2525	3564	41	5	1	45,12	3564	5.102,40	1,43

4 Service contracts

Service contracts are formal representations of the cooperation among a number of organisations. They consist of a static and a dynamic part. In the static part, we can find service specifications and prices. It can be set up with the help of the results from the simulation. For example, to determine a reasonable price for each handled unit, we can refer to the unit costs in Table 1 and use these figures as the basis for the cost calculation. One approach might be to take the average unit costs as an input for simple cost-plus pricing. Others might be to consider seasonal variations or to make the price depend on the difference between actual and reserved capacity. If we apply the latter approach to the simulation results mentioned above, we get a cost base of €1.34 plus 3 cents for positive deviations in steps of 10%, and €1.07 plus 26 cents for negative deviations in steps of –10% based on a linear regression on the full results.

The dynamic part defines the roles that each party to the contract plays and the activities it performs in the context of the cooperation. In principle, we could claim that the communicative model already contains most of the information necessary for the dynamic part but this approach is not sufficient for at least two reasons. Firstly, this model is typically very complex for realistic cases as the example of Figure 4 (which contains only a small part of the overall model) indicates. It is therefore unsuitable for communicating knowledge about the obligations implied by this process structure to the respective parties. But one of the most important requirements of a good contract is that the parties signing it should be fully aware of its implications.

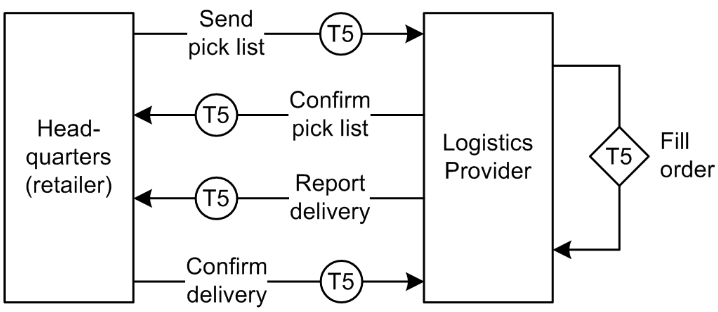
Secondly, the communicative model is hard to implement. It does not give us any directions as to which of its activities are supported by information systems integration and which are not. Both issues can be addressed by dividing the behavioural model into two components: business rules and collaboration models. The latter are detailed, workflow-like models of the cooperation. They are structurally very similar to the communicative models but they contain only a fraction of the actions. They show only standard, routine behaviour that can be performed or largely supported by service integration. This facilitates the enforcement of the contract.

The business rules then cover exceptional or non-routine behaviour. Such behaviour would crowd the collaboration models. It can be better represented in the form of a table. The next sections describe the development and the use of the collaboration models and the business rules in detail.

4.1 Collaboration models

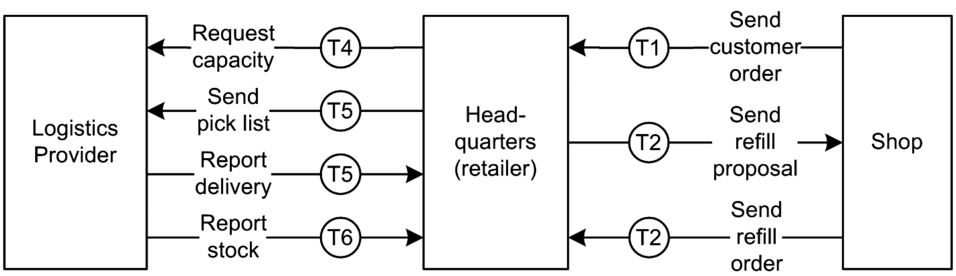
When developing the service contracts, we look at each business service in turn. We first create a communicative model of the respective business service as described in the section 'Business Service Models'. The result is a very detailed model with all the steps that have to be performed in the course of the business service. Figure 7 shows as an example of the communicative model that corresponds to business service T5.

Figure 7 Communicative model of business service T5



The aim of that business service is to fill the order, *i.e.*, to deliver the items contained in the order. It starts when the Headquarters send a so-called pick list to LogPro. This list names the products to be picked (and delivered) and their quantities. The associated activity is a routine activity and the information is important for controlling the process of filling the order. It will therefore be entered into the collaboration model (see Figure 8). The information systems of Headquarters and LogPro are integrated in such a way that the list is sent electronically as a 'pick file'.

Figure 8 Collaboration model



4.2 Business rules

The next step in business service T5 is that LogPro confirms the receipt of the pick list. As the warehouse management system of Headquarters mirrors that of LogPro, an out-of-stock situation cannot occur. LogPro only has to confirm that enough resources are available (staff, shelf space) to handle the order. As the reserved capacity (T4) is usually sufficient, an explicit confirmation is not required but is assumed per default. The respective communicative act therefore does not appear in the collaboration model.

Instead, we create a business rule that is activated in the case of an exception, *i.e.*, if the required capacity does exceed the reserved one by more than the specified percentage value (see Table 2, T5, promise). As a special arrangement has to be made for solving this problem in each specific case, this activity cannot be supported by information systems integration. The logistics managers at both companies have to negotiate this solution.

Table 2 Business rules

Business service	*Phase*	*Business rule*
T1	promise	A request to deliver items is granted per default granted and hence, not confirmed. In case of out-of-stock, a respective notification is sent.
	state, accept	covered by transition T3
T2	state, accept	covered by transition T3
T3	request, promise	covered by transition T1 or T2
	accept	If 'confirm receipt' was OK, no further message is sent. Otherwise, the claim is processed (return/resend).
T4	promise	A request for a capacity (forecast of required capacity) is always accepted and hence, not confirmed.
	state, accept	The provision of the requested capacity is guaranteed. Hence, no confirmation is required.
T5	promise	The pick list is accepted per default, no confirmation is sent. If the amount of items to be picked exceeds the limit specified in the service-level part of this agreement (in relation to the reserved capacity), a special arrangement is made (rescheduling of warehouse staff/higher unit price).
	accept	This is implied by the receipt of the delivery. If items are missing or wrong ones have been sent, a respective complaint is sent to LogPro and wrong items are returned to LogPro.
T6	request, promise	The updating of the retailer's warehouse system is done via an automatic, daily file transmission containing a stock report. Request and promise are therefore obsolete.
	accept	The receipt of the stock report is assumed. If transmission fails, manual troubleshooting will be invoked.

The productive action 'Fill order' is not considered in the service contract because it concerns only the internal behaviour of LogPro. The next step in business service T5 is that LogPro reports the delivery. This is a routine activity and Headquarters needs this information for billing purposes. It is therefore a part of the collaboration model. The final step, confirm delivery, is implied by the receipt of the delivery (T3). The exceptional case of a wrong delivery is handled by the Business Rule T5, accept (see Table 2).

The same is done for the remaining business services T1–T4 and T6. This leads to the complete collaboration model in Figure 8 and the complete list of business rules in Table 2.

Per default, we have assumed that the static part of the contract will consist of the prices and service levels. But in certain situations, these might also be dynamic (*e.g.*, high inflation, rapidly changing service requirements). In such situations, prices and service levels will become part of the dynamic part of the contract and the static part will be empty. This implies that the interaction model also covers price and service-level negotiations.

Given that the service contract is formulated in a rigorous way, it is possible to assess the service quality using objective criteria. The contract itself can be seen as a kind of workflow model that can be monitored by a workflow management system that detects behaviour violating the contract and initiates corrective measures. Details of this approach of interpreting service contracts as workflows can be found in Schmidt (2000).

5 A case study

The approach we have described so far was tested in a project that we carried out with representatives from both the Logistics Provider and its customer, a retail chain. One of the aims of that project was to improve the existing service contracts. Our approach helped us to develop a proposal for new contracts based on a thorough analysis of the business interaction. The old contracts were vague, which led to a series of problems:

- Indistinct communication structures: It was often unclear who communicates with whom regarding which issue.
- Lack of trust: Different interpretations of a contract by the parties led to expectations that were not fulfilled. An example of this is capacity reservation. Headquarters send an Excel sheet used internally, which it consider to be 'enough' but important information for LogPro's capacity planning is not present in this document.
- Lack of information: LogPro was not provided with the information it needs for a reliable capacity planning. This had not been specified clearly in the old service contracts.
- Excessive communication: A considerable amount of personal interorganisational communication was spent on handling everyday work. This was only necessary because of insufficient specification of routine procedures in the service contracts.
- High transaction costs: *Ad hoc* solutions to exceptional problems increased transaction costs.

Using the approach introduced in the previous sections, we developed a proposal for new service contracts that addressed Issues 1, 2, 4 and 5. The new contracts specified more precisely the obligations of each party concerning the behaviour at the interface between the organisations. This reduces the room for interpretation of the service contracts, which leads to more realistic expectations and ultimately to increased trust (Issue 2). The collaboration models clearly state who interacts with whom regarding which issue. This clarifies communication structures (Issue 1) and reduces the amount of 'unnecessary' communication (Issue 4). Business rules specify the behaviour in exceptional situations eliminating the need for developing *ad hoc* solutions. This reduces transaction costs (Issue 5).

6 Conclusion

A business action model of the interactions between organisations can contribute towards the design of service contracts. In particular, the interaction model of DEMO allows us to develop the static and dynamic parts of the service contracts. The former can be derived from the results of simulation runs. The design of the models required for this can be based on an interaction model of intra- and inter-organisational parts of the business process. The interaction model is also at the root of the business service models and detailed communicative models of each business service, which ultimately support the development of the dynamic constituents of the contract: collaboration models and business rules. The former represents routine behaviour that is typically supported or performed by an integration of the respective information systems and it is formally a reduced version of the complete communicative model that provides the same level of precision. The latter complements the former and describes the exceptional and/or situational behaviour in a less formal, textual manner in the form of a table.

Service contracts that are developed in this way are less ambiguous, which facilitates the implementation of the procedures and the enforcement of the rules and conditions. This can reduce transaction costs, the need for extraneous communication and the reliability of commitments. Ultimately, this leads to an increased level of service quality and improves the mutual trust among the participants in the cooperation.

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