

Towards an Ontological Foundation for Services Science: the Legal Perspective

Roberta Ferrario*, Nicola Guarino*, and Meritxell Fernández Barrera[°]

*ISTC-CNR, Laboratory for Applied Ontology
Via alla Cascata 56C, 38100 Trento
{ferrario, guarino}@loa-cnr.it

[°]Law Department
European University Institute
Via Boccaccio 121 , I-50133 Florence
Meritxell.Fernandez@EUI.eu

Abstract. As a growing number of economic transactions tend to happen in the Web, their legal implications and assumptions need to be made explicit in the proper way, in order to facilitate interoperability across different normative systems, encourage transparency towards the end users and ultimately promote trust in automated services. In particular, potentially ambiguous terms (and often apparently unproblematic ones) mentioned in these transactions need to be carefully analyzed in order to clarify the distinctions between slightly different meanings, describing hidden relationships and implicit constraints. One of these terms, highly overloaded nowadays, is “service”. Indeed, the very fact that services are now offered through the Web, and that the notion of service is at the core of a wholly new organizational paradigm – service-oriented systems – suggests the need to carefully (re)consider this notion. In this paper we shall attempt this analysis under the perspective of *formal ontology*, with a special attention to the legal aspects. The approach we take is that services are complex temporal entities (events) based on the central notion of *commitment*. Analyzing services as complex events allows us to clarify the relationships between the various agents that participate to these events playing specific roles, with specific responsibilities; moreover, this analysis explains a classic economic (and legal) distinction between services and goods, based on the fact that goods are both *transactable* and *transferable*, while services are transactable but not transferable. Assuming that transferability is intended as transferability of *ownership*, we argue that the ontological reason why services are not transferable is exactly because they are events: you cannot own an event, since if owning implies being in control of temporal behaviour, then, strictly speaking (at the token level), the temporal behaviour of an event is already determined, and changing it would result in a different event. So events are not transferable simply because they are not “ownable”. Since services are events, they are not transferable as well. Of course, this implies a shared understanding of what ownership, responsibility, duty, right etc. mean, and the paper is a first effort in this direction.

Keywords. Ontology, Services Science, Social Service, Service Content, Service Process, Service Description, e-Government, Responsibility.

1 Introduction and state of the art

Despite the ubiquity of the notion of service and the recent proposals for a unified *Services Science* [1], multiple inconsistencies between definitions of service from different disciplines (and even within the same discipline) still exist ([2], [3]). In particular, despite the general goal of this science is –arguably– to allow people and computers to smoothly interact with

services in the real life, many modelling approaches (especially those focusing on *Web services*) seem to focus mainly on the aspects related to *data and control flow*, considering services as *black boxes* whose main characteristic is to interoperate in a well-specified way (see, for instance, [4], [5], [6], [7]). This black box model has certainly its own advantages, but, according to a recent paper by Petrie and Bussler [8], apparently it seems to work well only within *service parks*, where run-time interoperability is technically feasible because services are very constrained. As the authors put it, “some interoperability among service parks might emerge, but it could take a long time”.

Focusing on services as business processes, on the other hand, has its own problems. Overall, the limits of the two approaches (Web services vs. business processes) are well described in a recent note by Katia Sycara [9], who observed that, on one hand,

“current Web services proposals don’t enable the semantic representation of business relations, contracts, or business rules in a machine-understandable way”,

while, on the other hand,

“current business-process languages [...] are at a low abstraction level and don’t provide formal business semantics”. In conclusion, “a need exists to model informal business requirements in ways that make it feasible to translate them into precise business-service specifications, including operational interfaces and rules for procedures, timing, integrity, and quality. Such modelling must be driven from the top down, directly from business requirements [...]. The modelling would provide a functionality that’s entirely understandable from a business perspective; it would depend on business context, goals, and operational standards, but shouldn’t depend on the technology used to implement them. The models would provide business value directly relating to business purposes and could be understood and used without knowledge of underlying IT artefacts”.

This is exactly the perspective we are adopting in this paper, which calls for a broad, interdisciplinary effort such as that envisioned by services science [1]. Under this perspective, we are convinced that a proper, general ontological foundation for the notion of service is a fundamental requirement for such endeavour. This is the long term goal of our work.

The present paper has two main purposes: first of all, we want to explore the foundations of a new ontology of services aiming at establishing a common, unifying framework for representing services according to different views, based on a vision that considers services as complex systems of commitments and activities, involving real people, organizations, and actual circumstances. In other words, we believe it is crucial to take into account the whole *service system* [2] that interacts with Web services through complex chains involving people and computers, which however have always *people* at their ends. That’s why in this paper – while trying to be general enough to account for any kind of service – we mostly emphasize the role of *social* and *business-oriented* services, adopting a *global view* which, in a sense, goes against the strict separation between the external and the internal view advocated by semantic Web services standards such as WSMO [10], [11].

The second goal of the paper is that of understanding how *responsibility* is distributed among different agents playing different roles in the whole service system. In order to do so, it is necessary to perform a comprehensive analysis of the notions connected to responsibility, including the juridical implications, which become particularly important in cases where services do not meet the customers’ expectations.

A first reason for a global, *transparent box* approach to service modelling comes from the observation that the *terminology* needed to properly expose, retrieve and interact with a ser-

vice, and especially that needed to understand and negotiate Service Level Agreements (SLAs), unavoidably requires a common understanding of the general service process structure, and the related activities involving the value exchange process between the producer and the customer (see [12] and [13]). Of course, in some cases service producers may have very good reasons for not exposing their internal workflow details, but the point is that, in general, SLAs *may* refer to some details concerning the *way* the service is implemented, whose nature is not specified in advance. So, since the boundaries between the external and the internal service description cannot be defined in advance for all kinds of service, a global approach seems to be the only viable alternative for a foundational ontology of services.

A further reason for a global approach focused on responsibilities lies in the fact that, in many cases, it is important to account for the way a service-based architecture impacts the organizational structure (indeed, service process re-engineering typically impacts organizational re-engineering). In this case, it is crucial to model in the proper way the links between services, people and organizations, where responsibilities play a crucial role.

For sure, modelling services according to this global view is not an easy task, however. The notion of service is so subtle and ambiguous that many researchers simply have given up adopting a clear definition, relying on a variety of intuitive notions mainly coming from practical considerations, which lack unfortunately a coherent framework. In other words, we are still facing the general question: *what is a service?* Is there a single notion behind this term? And if there are multiple aspects, how are they related? How is the internal view of services as *business processes* related to the external view of services as exposed (aggregates of) functionalities?

In this paper we shall address these questions by introducing a novel, general approach to service modelling founded on the basic principles of ontological analysis, centred on the notion of *service commitment* as a temporal state resulting from an agent's promise to guarantee the execution of certain actions in the interest of potential beneficiaries in correspondence of certain triggering events. In this view, services are modelled by means of a layered set of interrelated temporal activities, each one with its own participants and spatiotemporal location. Under this respect this approach shares many similarities, in its main inspirations, with Alter's work on service systems [2], as well as O'Sullivan's work on non-functional requirements for services [14], and Baida, Gordijn and Akkerman's work on the service value chain [15]. This proposal is meant to be a first concrete step towards a unified, rigorous and principled ontology. The analysis of the service system's structure and of the responsibilities distribution across this structure is necessary in order to build a model which is as faithful as possible to the social, business and legal perspectives.

The legal perspective, which is the main focus of this paper, is especially important in a world where international economic and political interaction requires communication between different legal systems, and ensuring mutual understanding becomes a strategic goal for guaranteeing conflict prevention and resolution. Indeed, the lack of unified conceptualizations in legal discourse can flaw the whole communication process, giving place to legal uncertainty, diverging interpretations of legal relations and – consequently – impasse situations that can only be solved through costly judicial procedures. Since the notion of service is a central one both for private and public law, the development of a foundational ontology of services plays an important role in the construction of a conceptual language for legal analysis. This paper aims therefore at providing a framework for the design of an abstract service model potentially applicable to different legal systems, where the notions of responsibility, liability and delegation are structured together, thus enabling the analytic description of services together with their juridical implications. Such detailed description, based on general legal notions such as duty, right and obligation, offers a formal framework useful to assess real life interactions and draw conclusions on the responsibility and liability of different ac-

tors. This is especially relevant nowadays where the puzzling complexity of contractual relations makes the task of liability allocation particularly intricate.

2 The proposed approach

2.1 The Basic Idea

If we start from the simple question “what is a service?”, it is immediately very evident that there is a huge confusion, not only in the layman’s common sense, but also in the way the term is used in the literature. Sometimes the term “service” is used to indicate an *action* (actually performed by somebody), or a generic *type of action* (including in this category data manipulation procedures such as those typically described as Web services), or perhaps the *capability* to perform some action; other times it refers to the *result* of such action, which is typically a *change* affecting an object or a person, or just the (subjective) *value*, or utility of such change; moreover, in certain settings (like Public Administrations) the term often denotes an *organization* acting (or in charge of acting) in a certain way in the interest of somebody.

In our opinion, all these notions are somehow connected, and contribute to better specify the notion of service, but none of them can be properly identified with what we believe people are commonly referring to when asking for a service. More or less “official” definitions occurring in the ICT literature do not help much (some relevant exceptions are [2], [14], [15] and [16]).

To see how these various definitions are related, let us start with some simple questions, focusing on very general public services such as fire-and-rescue, snow removal, children care, etc. What do we *pay for*, when we fund such services with our taxes? What does it mean that, for instance, in a municipality there are such services, at a certain time? Is anybody extinguishing a fire or removing some snow *at that time*? No, certainly not necessarily. We can legitimately say that *here and now* both a fire-and-rescue service and a snow removal service are *present*, even though there are no lit fires, nor is it snowing. It suffices to say that there is someone (firemen, snow removal operators) who is *prepared* to perform precise actions in case something happens (fire, snow). So our core notion of service is based on the following statement:

A service is present at a time t and location l iff, at time t , an agent is explicitly committed to guarantee the execution of some type of action at location l , on the occurrence of a certain triggering event, in the interest of another agent and upon prior agreement, in a certain way.

So, in a sense, at the core of any service there is a *commitment* situation in which someone (the service *provider*) guarantees the execution of some kind of *action(s)*¹ in the interest of

¹ Alternatively, instead of focusing on *actions* to be executed, one can decide to treat commitment as directed towards *conditions* to be achieved, as it happens in [1]. In this case, the commitment’s content can be expressed by a proposition. In the perspective of services, this difference amounts to focusing on the actions that must be executed in order to reach a certain desired state or directly on the achievement of such desired state. We could in fact leave this choice open, as the two alternatives seem both very reasonable: sometimes the customer is just interested in some particular state to hold, disregarding how it has been reached, other times the commitment concerns the action to be performed, even independently of the actual achievement of a specific result. In any case, we believe the latter case is more frequent and thus representing a commitment with respect to actions is more in line with our analysis.

somebody who agrees (the *service customer*), at a certain cost and in a certain way. This action is executed by the a *service producer*, who may coincide with the service provider, may be somebody else *delegated* by the service provider, or even coincide with the service customer (e.g. in rental services, where the action of using the rented good is actually performed by the service customer).

From the ontological point of view, this commitment situation is a static temporal entity, i.e. a *static event* in the sense of the DOLCE ontology² [17], which involves the participation of a single agent, the *provider*. This commitment state typically starts at the time of the commitment act, and its duration is determined by the commitment's act itself³, which typically specifies some constraints concerning the way the commitment will be fulfilled.

As we shall argue in the rest of the paper, service commitment needs to be distinguished from *service content*, which concerns the kind of action(s) the provider commits to guarantee, and *service process*, which is a set of business processes implementing the service commitment (see Figure 1). In turn, we distinguish service commitment from *service availability*, which involves a service process running at a certain time and location: this allows us to account for malfunctioning periods or working pauses, where the commitment still holds but the service is not available. Following [18], [19], [20] and [21], the commitment act can be seen as a *speech act* that most of the times is codified in a *document*, i.e. in an institutional object that can assume many different forms: a contract, an official declaration or deliberation, a service level agreement⁴, etc.

In institutional settings, the *provider*, the agent who commits, is typically a Public Administration. On the other hand, the *service producer*, who actually executes the action(s) guaranteed by the provider, may not necessarily coincide with the provider, and can be either a PA or another kind of (private) organization, delegated by the provider; in some exceptional cases even an individual agent. The same holds for the *service customer*, who can in turn be a PA, an organization, or an individual agent, the latter being much more common than in the previous case.⁵

The last element present in the definition is the *triggering event*; two kinds of triggering events can be singled out. The first one, more trivial, is a simple request made directly by the customer (like a parent in need who requires children care); in this case the *service invocation* coincides with the triggering event. The second one is the occurrence of a particular event kind, like the lighting of a fire in a wood, or a difficult situation observed by a social assistant, that triggers the action⁶. Of course, since the occurrence of the triggering event is not known in advance, the action time is in general much shorter than the availability time, so a service may be available at a certain time even if none of its foreseen actions do actually occur.

² Although the term “event” has often a dynamic connotation, we use such term in the more general sense of *entity which occurs in time* (also called *perdurant* in the DOLCE ontology). In this understanding, states and processes are considered as special event kinds.

³ We assume that the commitment act (the *speech act*) is instantaneous, and occurs at a time which does not necessarily coincide with the beginning of the availability state.

⁴ In the actual practice, the term “service level agreement” typically refers to the negotiation that the producer conducts with the user; here we are using the locution in a coarser sense, which includes also the provider-producer and provider-user agreements, as well as, possibly, those between the provider and the community to which services are provided.

⁵ In some cases, like in rental services, the service customer may coincide with the service producer. We do not discuss this case here, however.

⁶ To be more precise, it is the *observation* of such event that triggers the action. It is worth noting that, for this reason, many services include among their supporting activities an explicit monitoring activity, which can be executed by the producer itself or delegated to another agent.

It is worth stressing an original feature of our definition, namely the inclusion of the triggering event. Traditionally, approaches on services are goal oriented; take for instance the definition from [22]: “A service delivers a process to achieve a certain goal by using resources”. Note however that actually the goals may in some cases be just implicit, or even different if you compare the producer’s perspective with the customer’s perspective. In such cases, specifying the service also in terms of the triggering event and the action to be performed in correspondence of such event seems to be less ambiguous. The service’s goal doesn’t disappear in our approach, and indeed it is present in what has been called the service content, but the triggering event allows to justify the passage from service availability to service invocation. Moreover, note that a triggered action may not necessarily succeed. What the provider guarantees may in some cases be only the action’s performance, not its result. This changes also the mechanisms for the evaluation of service quality, which must distinguish between actions/processes and resulting states.

2.2 Services and goods

To better understand the nature of our proposal – that services are temporal entities (events) based on *commitments* – let us briefly discuss the difference between services and goods. According to the World Trade Organization, services are a sort of intangible goods, so that a service might be defined as anything you can buy, but “you can’t drop on your foot”. Yet, Ted Hill [23] insists on the fact that services are not a special kind of goods, because goods and services belong to quite different ontological categories: goods are both *transactable* and *transferable*, while services are transactable, but not transferable. In Hill’s own words, “a surgical operation is not some kind of immaterial drug”: when you buy the drug you become an *owner* of it, in the sense that you can decide about its behaviour (i.e., assuming it in your body), while when you pay for the surgical operation you are not actually becoming the owner of it⁷. In support to this argument, we argue that the ontological reason why services are not transferable is exactly because they are events: you cannot *own* an event, since if owning implies being in control of temporal behaviour, then, strictly speaking (at the token level), the temporal behaviour of an event is already determined, and changing it would result in a different event. So events are not transferable simply because they are not “ownable”. Since services are events, they are not transferable as well.

So, in conclusion, it seems legitimate to assume that goods are *objects* (endurants, in DOLCE’s terms), while services are *events* (perdurants). One may observe however that our economy is full of examples of transactions involving services, where the service seems to pass from hand to hand: certainly somebody may buy Amazon, for instance: our point is that in this case the transaction involves the *Amazon company*, not *Amazon’s service*: there is a change of ownership concerning the service producer, but not the service itself, which remains the same (as long as the Amazon company doesn’t change its legal identity, and its service content – the actions it offers – remains the same).

Transferability of services as transferability of a right

We have seen that a service, being an event, is not transferable. However, certainly we can transfer a right *to a service*. In the context of services, a right to a service implies a deontic position, in the sense that someone has a right if there exists a certain corresponding duty. A right of *A* of receiving a service would correspond then to the duty of *B* to provide the service, namely, to the duty of participating (as the main agent) in the *commitment event* that is

⁷ An interesting analysis of the notion of ownership can be found in [24].

at the basis of every service. A right can be reified, that is, considered as an object, and this is actually a common move in the legal domain⁸. And a right can be *owned*, in the sense that somebody can decide how to affect its “behaviour” (e.g., deciding *when* the right is claimed).

What is the conclusion of this conceptual analysis with regard to the notion of service? That even if a service is not directly transferable, since it is an event, *rights to services* are transferable: the object of the transmission is in this case the right, and the service is the event which the right refers to. In other words, having the right to a service is the same as being able to legitimately claim the performance of a certain service (set of actions) by some other party. And what can be transferred, from a legal perspective, is precisely this legal position that enables someone to legitimately claim the performance of a service.

A similar analysis can be applied to the notion of “good”. In this case however the ownership (intended as the capability to influence the temporal behaviour) concerns the good itself, and not just the right to use it. In other words, we can own a good *in addition to* owning the right to exploit it, while for services the only thing we can own is the right to exploit them. Note that, although in many cases ownership transfer for goods implies a physical transfer (change in physical location), this is not always so, as in the case of real estates.

Transferability of services as transfer of a duty

From the provider’s point of view, a service transfer might be understood as well as the *transmission of the duty to provide the service content*. However, we should distinguish between *total* transfers of this duty from an agent to another (including all related responsibilities towards the service customer), and *partial* transfers (i.e., *delegations*), which maintain some responsibilities on the side of the delegating agent. The latter case is typical of public services, whose content is to be guaranteed by the state. Indeed, the public entity can *transfer a part of the duties* that compose its obligation to a private entity –namely, the obligation to actually *produce* the services in specific circumstances- but not its general duty and it will therefore keep part of the responsibility. Let us imagine health services. Health service can be a public service in the sense that the State has the responsibility of guaranteeing it. The State can, however, agree with a private party (private medical company) that whenever citizens need health assistance, the private party will provide it. The responsibility over the service remains in the State, since it cannot completely delegate this duty⁹. However, the particular duty of satisfying concrete needs arising from specific situations (e.g. concrete medical care needs derived from the situation in which someone breaks his leg) is assigned to the private entity to which the service is entrusted. The duties related to health services are thus split between the state (the *provider*) and a private actor (the *producer*). A similar situation occurs in the case of subcontracting, by which the general contractor delegates to the subcontractor the performance of a specific task, keeping nonetheless responsibility towards the client.

On the contrary, a *total* transfer of duty can happen in the private sector, where we can distinguish two cases, depending whether the duty comes from a *generic* commitment towards potential customers, or a specific commitment concerning an *actual* customer, under specific circumstances. In the first case, it is common to talk of business transfers. This means that, if a business provides a private service with no special limitations on its transfer (and assuming that the service buyer fulfils all the necessary legal requirements), the full responsibility is simply transmitted to the acquiring party (let us imagine for instance the previously mentioned transfer of Amazon, or the transfer of a restaurant, or a hairdressing salon). In the sec-

⁸ Rights were already clearly distinguished in Gaius’ classification of the law: “Res incorporales: things which cannot be touched, such as those consisting in rights, e.g. an inheritance, a usufruct, obligations”.

⁹ And this would therefore imply that complaints can still be directed to the State in case the service provided by the private company does not work well.

ond case, the transmission of a particular service, that is, of the concrete obligation to provide a service to a party, will be possible if this does not substantially alter the quality of the service contracted by the party or, if otherwise, the latter provides consent (let us imagine for instance that we reserve a room in a hotel and when we get there the hotel is full and they send us to another hotel within the same group).

As a conclusion, let us insist that, despite the cases above can be described as service transfers in the everyday jargon, properly speaking, according to our definition, the transfer does not involve the service itself, but rather certain *normative positions* (duties or obligations) that refer to it. Moreover, we maintain that, while an internal delegation process concerning the actual *production* of service content certainly does not alter the identity of a service under our definition, a *total* transfer of duty implies the existence (or the creation) of *another* service, different from the original one. If the owner of Amazon changes, while Amazon maintains its legal status and its service content remains the same, then the service remains the same, because the provider is still the same. On the contrary, if the provider changes (e.g., because the company dissolves after being bought by another), then the service changes, although the service content may remain the same. Suppose that for instance there are two companies, A and B, providing exactly the same service content (possibly at different prices). According to our definition, we say that there are two distinct services. If now A buys B (that is, the *company* B, with all its duties and rights, is transferred to A) the result is that the service provided by B disappears, and only one of the previous services survives.

2.3 The basic ontological structure of services

Let us continue our analysis with another question: what's happening when a service is *produced*? As we have seen, a service may be concretely available even if it is not actually delivered, or maybe will be never delivered: we keep paying the firemen even if no fires occur. So, in our approach, a service has to be distinguished from its actual *delivery* to a particular customer. Indeed, typically the same service guarantees multiple deliveries. By the way, to avoid confusions, we propose an important terminological distinction: strictly speaking, it is not *the service* which is delivered, but its *content*, i.e., the actions intended to be performed in the interest of the customer. So a service implies first of all a concrete commitment (from the side of a *provider*) to guarantee the production of a certain content, consisting in actions of a certain kind executed in a certain way. Altogether, the various actions that ultimately lead to service content production (performed by the service *producer* on behalf of the provider) constitute the *service process*. We shall say that a service process *implements* a service commitment. The concrete delivery to a particular customer presupposes however a *service acquisition* activity engaged by the latter, which typically negotiates a *service offer* resulting from *service bundling and presentation* activities on the producer's side. Finally, to complete the picture, we have to take into account the activities related to the value exchange chain, which include the service exploitation from the customer's (*customer's exploitation*), the sacrifice needed to access to the service (*customer's sacrifice*), as well as the corresponding activities from the producer's side.

So, as illustrated in Figure 1, a service is conceived as a complex event, with five main proper parts: service commitment, service presentation, service acquisition, service process, and service value exchange. In the following, we shall discuss these notions in more detail, with the aim to establish the basis for an ontology of services able to account both for *service descriptions* from an external point of view (typical of Web services and Service Oriented Architectures) and for *service processes* from an internal, business modelling point of view.

First of all, let us remark that all the blocks described in Figure 1 are *events* (*perdurants*, in DOLCE's terminology). This means that they can be characterized, roughly, by their *tempo-*

ral location and by their participants, linked to the event by means of what are usually called thematic relations: agent, patient, theme, instrument... Specifying a service (or a service kind) amounts to constraining these events by imposing suitable restrictions on their temporal locations and thematic relations. So, for instance, non-functional requirements such as those discussed in [14] are represented as attributes of specific service components, each involving a particular aspect (participant/thematic relation) of a particular service event. The resulting analysis, which we cannot discuss in detail for reasons of space, looks very similar to Alter's service responsibility tables [2], where the rows correspond to service components (events), and the columns to specific aspects to be considered (thematic relations). We give therefore a clean ontological foundation to a business-oriented proposal. Moreover, specifying the agents involved in each event allows for a fine-grained account of the organizational impact of a certain service. Note that, although the relationships between these various events (for instance, whether or not they involve the same agents) may vary according to the nature of the service specified, there exists a systematic ordering relationship between them, so that a service has a layered structure. This ordering relationship is not so much a temporal precedence (indeed most of these events are temporally overlapping), but rather an (existential) ontological dependence relationship: in order for an event at a certain layer to occur, some event at the higher level has to occur. Ultimately, all the events belonging to the service process presuppose some acquisition event, which in turn presupposes the service commitment.

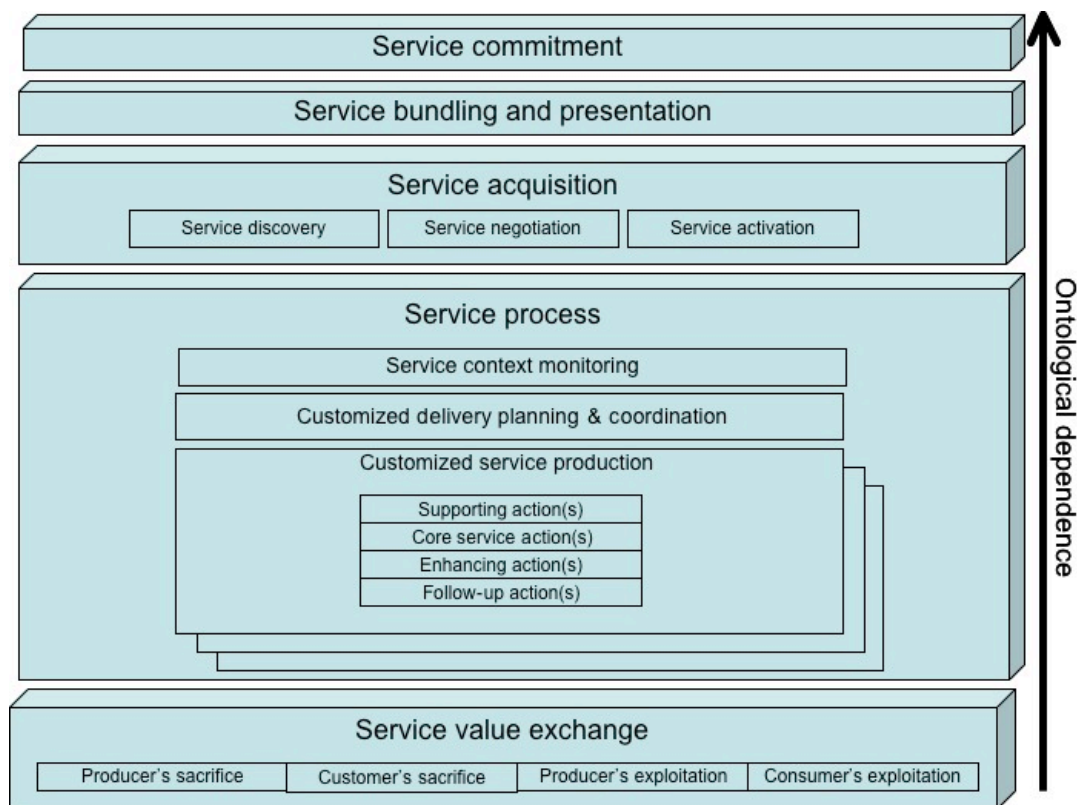


Figure 1: The layered structure of service activities

At this point it is important to notice the central role played by actions and events in this account for the description of services; this is in contrast with the major trend, which is to describe services in terms of pre-conditions and post-conditions, like in WSMO, where pro-

cesses are represented as transitions between states [11]. Under a different perspective, the two approaches could also work in conjunction.

There are several reasons why in our opinion it is important to explicitly represent events; first of all, though for the front-office in most cases it is enough to know which is the starting state and which the desired one, for the back-office it is important that the whole process be transparent (to know who does what and when), especially when a failure is at stake. But malfunctioning is not the only reason: without events one does not have sufficient expressiveness to distinguish two different commitments with the same content but different deadlines. Even if one sees these deadlines as non functional properties, it is hard to use them, say, for expressing a SLA without a clear semantics.

Again, in [25] a list of service quality's determinants is given, in which at least a couple of these determinants are strongly space-time dependent: responsiveness, connected with timeliness of service and access, defined by (among others) three items: "waiting time to receive a service [...]; convenient hours of operation; convenient location of service facility."

By using only pre- and post-conditions other subtle but important differences are lost. Take for example these two scenarios: 1. an unemployed woman who becomes pregnant and 2. a pregnant woman who becomes unemployed. In our account, the two scenarios can be distinguished by the fact that in 1 the pregnancy is the triggering event, while in 2 it is the unemployment. This difference may result in the activation of different services (for instance, a financial aid in 1 and a help in searching a new job in 2, or a legal enquiry on the employer if there's a suspicion of unfairness). In a pre- post-conditions framework both scenarios have the same pre-conditions and thus should activate the same services. Notably, the literature in economics has since long recognized that comparing the outcomes of services is not enough in order to evaluate their quality. See for instance [25] (similar distinctions appear in [26], [27], and [28]):

Quality evaluations are not made solely on the outcome of a service; they also involve evaluations of the *process* of service delivery.

Let us now consider the various events constituting the service process internal structure. In Fig. 1, the containment relationship between the various blocks represents the parthood relationship. The core constituent of a service process is a set of basic activities (each called *customized service production*¹⁰), centred on the delivery of service content to a *single customer*. In addition to the *core service action(s)* depending on the service nature, a customized service production may include *enhancing actions* intended to increase the service value or differentiate it from those of competitors [23] as well as *supporting actions* needed to enable the core service consumption and *follow-up actions* intended to monitor the core action's results. In addition to customized delivery activities, the service process includes various back-office activities concerning *customized delivery planning and coordination*, plus an activity we have labelled as *service context monitoring* –which seems to be neglected by most current approaches – which involves the various actions necessary to detect the event that triggers service production, which can be an external situation or a customer's request: without an explicit modelling of such activity, there would be no way to account for delays or improper management of triggering events.

As a presupposition to service production, typically some *service acquisition* activities are required from the side of the customer¹¹. These include *service discovery*, which is the event

¹⁰ In the context of public services, a single event of customized service production is often called an *intervention*.

¹¹ Even in the case of free, public services, it is difficult to imagine a case where the customer is not required to actually discover the service, or make a minimal sacrifice to exploit it.

where the service provider (or producer) and the service customer first meet together; *service negotiation*, which involves an agreement between the two parties, and *service invocation*, which refers to the event where the customer agrees to the service (not necessarily implying immediate production).

On the other hand, the service production results in a complex chain of transfers of value, which are represented in Figure 1 as the event Service value exchange. With a simplification, this is decomposed in *Producer's cost*, *Customer's cost*, *Producer's revenue* and *Customer's revenue*.

While in the case of the producer, most of the times (both for cost and for revenue) the value has to be intended in terms of money, in the customer's case things are more complicated. For instance, especially for services in the social domain, the customer's cost can be seen as an action whose results go somehow against some of the recipient's desires, but which the customer is still willing to perform, like the *service sacrifice* mentioned in [11]. Also the customer's revenue sometimes is not expressible in monetary terms, but only as some wellness state. Moreover, even though there's always an ultimate recipient of a service, we could also have indirect recipients, like the community that pays with its taxes for the service and benefits in terms of enhancement of its social conditions.

In conclusion, we can say that a service is characterized in a *prescriptive way (commitment level)*, while a service process in a *descriptive way (implementation level)*. The commitment level is where the "rules of the game" are established: what types of action compose the service, what types of agents are entitled to execute those actions, what types of agents may qualify as recipients, what types of events can become triggering situations. It is also the level where legal responsibility is at stake. In fact, from the point of view of the service offering, it is not important who in particular executes certain actions, but rather that a certain kind of action is executed in a certain way, by an agent who displays certain features and has some competences. The agent who is responsible that the required conditions are met is usually an organization, such as for instance a public administration. Such responsibility is usually distributed and assigned according to some structural constraints, i.e. by devising a structure of roles and sub-organizations. The ontological analysis of organizations is thus a topic tightly connected to the ontological analysis of services.

When we come to the actual service process, the various *kinds* mentioned at the commitment level need to be instantiated in concrete *tokens*. Individual agents are those who realize the core actions of service production, whose recipients are, ultimately, concrete agents (citizens); also the triggering situation is the occurrence of a precise (instance of) event. The service production level is thus characterized at the *descriptive level*, the one the data that are recorded and transferred belong to.

Finally, let us mention the issue of spatio-temporal location of services. In very general terms, one could say that in most cases when a somebody makes available a service, this availability spans over a spatio-temporal region which includes the spatio-temporal region in which the core service actions will (possibly) be executed; in rare cases, the two can coincide. For some special services, the analysis can be further complicated by the fact that the service may be delivered in a place and at a time and received in another place at another time. We won't enter into these details at present, but the issue needs to be investigated.

3. Responsibility, right, duty, obligation

3.1 Connections between the main notions

Before exploring in more detail the juridical implications of services in terms of the layered structure of interrelated events described above, let us focus in this subsection on the notion of responsibility, which is quite central in the study of services, analysing it under many re-

spects, including its significance from a juridical point of view and its connection with the related notions of right, duty and obligation.

For a start, a definition of responsibility that can be found on a common business dictionary¹² is the following: “Duty or obligation to satisfactorily perform or complete a task (assigned by someone, or created by one's own promise or circumstances) that one must fulfil, and which has a consequent penalty for failure.”

As we can see, this definition includes both the possible sources and the common consequences of responsibility. As possible sources it mentions both an exogenous assignment (as in the case of delegation, that we will see in a while) and a promise coming from the same agent who's taking the responsibility (as in the case of commitment). Note that, if there is an exogenous assignment, the corresponding commitment is not necessary: for instance, a government may be responsible for the population's health without actually committing to it. In any case, the consequence of having (undertaken) a responsibility is to become the bearer of an obligation that, if not fulfilled, would bring about a sanction (which is the last element of the definition above).

When responsibilities are institutionally established and codified in a contract (such as a Service Level Agreement), then a relationship originates between the service provider and the service customer, such that then each customer's rights is connected to a correspondent obligation for the service provider; very often this obligation is accompanied by a possible sanction, in case the obligation is not fulfilled.

The right of the customer to have the service fulfilled, and the belief that the agent will be sanctioned in case it is not, engenders an expectation in the customer that the service will be delivered.

If we look at it from a juridical perspective, *responsibility* refers to the situation of being accountable to someone for something. There exist many types of responsibility depending on the kind of normative order that makes one accountable: social responsibility if the normative order is the social order, moral responsibility if the normative order is a particular moral system and legal responsibility if the order is a legal system, among others. The core meaning of the notion of responsibility involves therefore the existence of a certain kind of normative order that should be observed.

In the legal domain, a difference is made between the general notion of social responsibility and a stricter notion of *liability*, which refers to the elements that are generally required for incurring legal blame because of the violation of a social responsibility, and, in private law, for being compelled to comply with a court order to pay damages or compensate in some other way the damage done [29]. Criminal liability entails punishment, which frequently takes the form of imprisonment. This way, legal responsibility (liability) can be seen as the concept that enables to blame someone for unlawful action. Once the responsible subject is declared liable, actions can be taken to compel him or her to compensate the harm done or to punish him or her.

Legal liability requires the existence of an agent, whose conduct is considered legally relevant; a patient, affected by that conduct; the conduct or action; and the wrong or harm, understood as the effects on the patient. Agent and patient do not necessarily have to be concrete physical persons; in private law both agents are private parties, in public law the harm is in general terms not merely caused to an individual party, but to the community or to the general interest (this is one of the criteria for distinguishing private law and criminal law).

Note that, as observed above, legal responsibility (liability) inherently requires *a pre-existing normative order against which to judge the agent's conduct*. This normative order

¹² <http://www.businessdictionary.com/>

can be translated into particular *normative positions* (rights and duties). These normative positions define the liability-responsibility relation and permit to allocate specific roles to the agents involved. A landmark contribution to the notion of duty and right is [30], where an analysis of fundamental juridical notions is presented. In this work “duty” and “right” are considered correlative concepts that can be represented through the following scheme: “[...] if X has a right against Y that he shall stay off the former's land, the correlative (and equivalent) is that Y is under a duty toward X to stay off the place.” [30]. If X’s duty (or obligation) is not fulfilled, then there will possibly be legal responsibility and liability.

Taking into account this general framework and according to the model of services presented above, in the context of services provision we can envisage different sources for legal responsibility (liability):

- breach of contract (of obligation) [*contractual responsibility*]
- specific damages resulting from the breach of contract [*contractual responsibility*]
- specific damages resulting from the wrongful performance of service: civil and criminal responsibility [*extra contractual responsibility*].

These different types of legal responsibility (liability) are connected to the breach of different kinds of duties or obligations. Let us imagine a public service, namely, health care. We can distinguish different duties in this regard:

1. the duty of providing particular health care services (doctor assistance, medical tests, diagnosis, treatment, ...) at particular moments and to particular individuals. It is therefore a contractual obligation or duty.
2. the duty of performing the actions directed to provide health care services according to general diligence (standards of conduct in the medical field determined by the community of medical professionals and their practices) and according to certain conditions explicitly established in a certain context. These latter conditions can be established by the regulation (in a particular country) for health service providers. It could be regarded therefore as an extra-contractual obligation or duty.

If duty 1 is not fulfilled, this can be seen as a breach of contract (obligation) and as specific damages resulting from the breach of contract; whereas if duty 2 is not fulfilled, this could be regarded as damages resulting from the wrongful performance of the service: civil and criminal responsibility.

The previous scheme can be applied to the framework of public services. The cases presented can be understood in terms of abnormal function of the public service, according to Principle I of the Council of Europe Recommendation R (84) 15 of the Committee of Ministers to Member States relating to public liability:

“Reparation should be ensured for damage caused by an act due to a failure of a public authority to conduct itself in a way which can reasonably be expected from it in law in relation to the injured person. Such a failure is presumed in case of transgression of an established legal rule”.

However, state liability is not excluded in case the function of the service is normal, if it is considered unfair that the citizen bears the damage. This is stated in principle II.1:

“Even if the conditions stated in Principle I are not met, reparation should be ensured if it would be manifestly unjust to allow the injured person alone to bear the damage, having regard to the following circumstances: the act is in the general interest, only one person or a limited number of persons have suffered the damage and the act was exceptional or the damage was an exceptional result of the act.”

The transferability of these different responsibilities varies. Responsibility travels along with the corresponding normative position, that is, with the specific duty. If the duty is transmitted to a private party, the corresponding liability is as well transmitted. Nevertheless, the more abstract statutory duty consisting in the obligation to guaranteeing the existence of a structure or organisation that provides a particular service is not transferable. This duty is established by laws, quite often constitutional texts, which determine that the state is responsible of guaranteeing certain public services to which citizens have a right. This is why some peculiarities exist in the regime of public responsibility. For instance, the establishment of strict liability, which affects not only the state, but as well the private bodies that are providing the service on the basis of a license [31]; or, even if the service (duty 1, duty 2) has been transferred to a private entity, complaints might have to be directed to the state (this was once the case in Spanish regulation [32]). The state could be held liable as well, for instance, in case the statutory certification bodies had not performed well their task and had granted permission to operate to a private medical centre that did not fulfil the minimal conditions and some concrete injury had been caused to a patient. It could be held responsible as well in case the damage was due to a compulsory clause imposed by the state in the public contract granting permission to the private entity to provide the service.

3.2 Patterns of responsibilities, obligations and rights across service structures

The starting point of our analysis is the event of service commitment, in which a service provider commits with someone (a community, or an authority) that a certain service content will be produced for the benefit of a designated kind of customer.

In the literature a distinction is traced between implicit and explicit (or “explicitly represented”, in Singh’s terms) commitment, that goes back to the more traditional approaches, like that of Becker [33], who distinguishes between commitment by default and commitment by conscious decision. In institutional settings the commitment is usually codified in a document, like a contract (and gives rise to contractual responsibility); this contract creates new juridical entities: it creates an obligation for the provider; this may be a direct obligation to perform certain kinds of actions or it can consist in seeing to it that such kinds of actions are performed by someone else. In this latter case the contract envisions also a delegation action. When a provider delegates the execution of a service to a producer, the action creates an obligation on the side of the producer (of executing the service) and a right from the side of the provider (of having the service executed, so as to be able to fulfil its previously determined obligations towards the community or authority whom the commitment was addressed to). Delegation relations may be seen as responsibility transfers between agents. As noted in the previous subsection, if the duty of executing the action is transferred (delegated), also the responsibility of that action is transferred; nonetheless, the obligation of guaranteeing that the service is executed (which pertains the public authority that plays the role of provider) is not transferable. It is interesting to notice that in [21] Singh explicitly lists delegation among the operations that can be executed on commitments. He also highlights the fact that when a commitment is delegated, agents shift their roles: he says that the role of debtor is shifted, that is to say that the commitment passes from the provider to the producer, who has now the

responsibility with respect to the execution of the service actions. We are aware of the fact that this description is a simplified one, as the responsibility can sometimes be shared in varying proportions.

In [34] a classification of different types of delegation relations based on three dimensions is traced. In particular, along the first dimension, based on the nature of interaction, the authors distinguish between weak, mild and strong delegation: in weak delegation there is no agreement, no requests and no intended influence, so that the one who delegates just exploits the actions of the other; in mild delegation there is still no agreement and no request, but the desired behaviour is in some way induced; finally, in strong delegation there is an explicit agreement on which the delegation is founded. It is obviously this latter type of delegation that is at stake between service provider and producer, as the delegation in this case comes into being just with the signature of a contract or some other formal agreement.

Another dimension that is of interest for this discussion is the one based on the degree of task specification, that distinguishes between open, close and intermediate delegation, depending on whether the object of delegation is more or less specified, in a spectrum ranging from open delegation with minimal specification to close delegation with complete specification, with various degrees classifiable as intermediate delegation.

The degree of specification of the delegation depends on what is written in the delegation agreement or contract, similarly to the case of the service commitment contract, where the commitment's content can be more or less specified concerning the way the core actions are executed.

Disregarding who is in charge of executing the service actions, the commitment also creates a right on the side of the customer.

Even though, as we just mentioned, in most cases public institutions make their commitment public through a contract or a deliberation, it happens very often that, while the assumption of the commitment on the side of a public entity is explicit, its acceptance by the beneficiaries is only implicit and given "by default" by their belonging to a particular social community. This default acceptance assumption ensures that the beneficiary can claim the execution of a certain service even without having signed any contract or having negotiated anything with anybody on this respect.

The chain of rights and obligations generated by the commitment event also imposes various kinds of constraints on the other events composing the service. For example, during the activities of service bundling and presentation, the service producer is constrained in that it cannot promise anything that is excluded by the contract signed at the time of the commitment event. Also, what is advertised in the presentation must not be anything that cannot then be executed. The fact that the service is presented in a certain way may also give additional rights to the customer, like the right to have it executed in the way in which it has been presented (not always, sometimes if the contract doesn't explicitly commit to execute the service as it is advertised in the presentation phase, it may be that the customer does not acquire such right, but at least the producer becomes liable of being sanctioned for what it has promised and then not fulfilled. In this case maybe the customer can be refunded, thus acquiring another, different, right).

Also the service negotiation phase is very important from a juridical standpoint, since when a new contract with a specific customer is signed it has to comply with what established in the general commitment contract, but it can add details to that. This customized contract makes the producer's obligations more precise (possibly adding new obligations) and creates specific rights for individual customers (differently from the commitment, where rights were attributed to classes of customers).

The service process is the phase in which what has been promised in the commitment and in the negotiation phases is realized. According to the level of detail of the contracts resulting

from these two phases, the various actions of the service process can be executed in a more or less pre-defined and specific way.

It is important to notice that the service process also includes a service context monitoring activity. The way this monitoring is performed is also regulated; usually, this regulation is primarily given in the commitment, where the provider also commits on monitoring, but can decide whether to execute such monitoring directly or to delegate it to someone else. This delegation can be directed either to the producer of the service, or to a different entity, that is then only in charge of the monitoring. In case it is delegated to the producer, this can further delegate it to some other entity.

The commitment towards monitoring (be it direct commitment or a commitment acquired via delegation) and the consequent rights and obligations that it brings with it, underline the importance of the triggering event in the structure of the service. If the entity in charge of monitoring fails to detect the presence of the triggering event, the service process cannot be initiated. In this case it is not the service producer that has to be deemed responsible for the failure of the service process, since this was not initiated due to the lack of the “start signal” given by the detection of the triggering event.

Finally, after having verified that in the service process phase all that was promised in the previous phases has been properly realized, a right of receiving some income on the side of the producer arises in the service value exchange phase. Consequently, for the provider (or the community in public services’ cases), an obligation of providing such income to the producer is created. The amount of such exchanges is usually fixed in the negotiation phase. If the contract also specifies some constraints in the customer’s costs (for instance, the fact that a service has to be produced in a restricted timeslot) and these are not met, a new negotiation phase can take place.

4 A revised version of Alter’s responsibility tables

An author who also deems the concept of responsibility as central for service science is Steven Alter, who, in a recent article [2] has presented a conceptual instrument that he calls “service responsibility tables” (SRT); these are aimed at facilitating a better understanding of services primarily based on the responsibilities assigned to each role; moreover, Alter suggests to add as many columns as necessary in order to address different aspects of analysis. In practice, Alter isolates two orthogonal components of services: the constituting actions and, for each of these actions, the responsibilities of the involved stakeholders; he thus describes *how* such stakeholders participate to the various events. These *modes* of participation individuate the *role* the participants play in the various events constituting the service.

Even though the topics suggested by Alter are heterogeneous and sometimes confusing, we are interested in his idea of representing the events composing a service and the role participants have in these events and in using the tables to represent the distribution of responsibilities across the events composing the complex structure of the service system.

In order to represent all this, we take inspiration from a notion introduced in linguistics to account for the internal structure of events: so-called *thematic relations* (or *thematic roles*), expressing the nature of the relationship between an event and its participants. Adding thematic relations to those linking an event to its own qualities (such as temporal and spatial location) we have a full set of attributes at our disposal, among which the following ones appear to be as especially relevant for our purposes:

- Agent (the active role, the one who acts in the event)

- Theme/Patient (the one who undergoes the event; the patient changes its state, the theme does not)
- Goal (what the event is directed towards – typically a desired state of affairs)
- Recipient/Beneficiary (the one who receives the effects of the event)
- Instrument (something that is used in the performance of the event)
- Location (where the event takes place)
- Time/duration (when the event takes place, or how long it lasts)

As a result, in the service responsibility table we have the main composing events in the rows (service commitment, service acquisition, service process, service value exchange...) and the thematic relations in the columns.

In order to give an idea of the approach, we take an example and we represent it using the tables. The example is directly taken from [23] and it is about a guy who goes to the mechanic's garage to have his car repaired. The aim of Table 1 is that of representing in an explicit way the fundamental constraints that need to be specified in an actual service description. This can bring many advantages both in the comprehension of the service's features and in the many different evaluations of service quality that can be made under various viewpoints, among which the legal one, that is particularly relevant in this context.

The table describes the events in which a generic car repair service is articulated. The values we put in the various cells allow us to express the relevant constraints that distinguish this service from others.

We start with service commitment. During the commitment event, that chronologically comes first and is the one that all the other events depend on, the garage's owner commits with a Public Administration (for instance the Chamber of Commerce) with a subscription act and his commitment consists in guaranteeing that someone (the mechanic) will execute a certain type of job (illustrated in the job description, on which he commits) according to the local rules. This commitment is valid in the whole Province (for instance) and starting from that very moment on.

After the commitment, we have the service acquisition, which in turn is composed by three different events: discovery, negotiation and activation. During discovery the customer looks for a garage (that is then the *theme* of his search) with the goal of having his car repaired. Note that not all the cells in this line are filled, meaning that, for instance, the instrument used for the discovery activity is not specified. Should we describe a service based (exclusively) on a certain mediator for the discovery process, the name of such mediator would be specified in the "Instrument" cell.

After the service is discovered, the negotiation between customer and mechanic starts; the goal is (probably) an agreement and the negotiation is on the service customization (in other words, how the service type in the job description is tailored to the customer's needs). At that point the mechanic activates the service, i.e., the related scheduling and organization activities. The last two events usually take place in the garage and the whole service acquisition event is performed after the commitment has been taken and before the occurrence of the actual repair.

The actual service process (as can be noted from Figure 1) is a very complex one, consisting of a lot of interconnected activities; here, for simplicity reasons, we choose to represent only the service's core actions.

In the service process event, the mechanic, with his tools and in his garage, performs some actions on the car aimed at having it repaired; this in the interest of the customer.

Finally, there is an articulated service value exchange event, which is constituted by a bunch of activities corresponding to what counts as a "sacrifice" or an "exploitation" from the producer's and customer's points of view. This is a complex topic, that deserves a more

Table 1: The Garage example

		Agent	Theme/Patient	Goal	Recipient/ Beneficiary	Instrument	Location	Time/duration....
Service Commitment		Garage's owner	Job description		PA (Chamber of Commerce)	Subscription act	Province/Region?	Starting at fixed date before, opening, until the duration of the license
Service Acquisition	Discovery	Customer	Mechanic	Car repaired				After opening and before actual repair
	Negotiation	Customer, Mechanic	Service customization	(Agreement)			Garage	
	Activation	Mechanic	Internal execution plan				Garage	
Service Process		Mechanic	Car	Car repaired	Customer	Mechanic's tools	Garage	Period in which the repair actually occurs
Service Value Exchange	Producer's sacrifice	Mechanic	Working hours	Being payed			Garage, bank...	A certain time (usually) after that the car has been repaired
	Customer's sacrifice	Customer	Money, car's unavailability, time needed to pick-up car...	Car repaired				
	Producer's exploitation	Mechanic	Money					
	Customer's exploitation	Customer	Car repaired/car availability					

thorough examination, because both the components of cost and those of revenue can be many and different evaluations can be conducted with different purposes. Simplifying a lot, here we can say that the mechanic counts as a sacrifice his working hours with the goal of being paid, while the customer counts as a sacrifice the money he pays, the time to go to the garage, the time the car is unavailable and so on with the goal of having the car repaired; the mechanic earns money, while the customer's revenue consists in having his car available again.

There are some remarks that can be made; first of all, from the knowledge representation point of view, one thing that can be easily observed is that some values must be the same across multiple cells; for instance, the mechanic plays a role of agent in service process, while he plays the role of patient in service acquisition. This might be a problem, as most languages ordinarily used to talk about services (like those based on description logics) are not expressive enough to account for co-reference between variables.

Another remark – a methodological one – is that these tables can be further refined, for example by decomposing the service process event in its internal layers.

Even though the example is quite elementary, it is already possible to see how much additional information the table can convey. The table can also help visualizing the responsibility relations specific to definite events that can be deduced by looking at how the thematic roles in the event are filled. For instance, it is easy to infer from the table that the garage's owner is responsible of the availability of the car repair service, as it is described in the job description according to what it is written in the subscription act signed with the Chamber of Commerce. Similarly, the mechanic is responsible of executing the repair as it has been agreed with the customer in the negotiation phase. As we already noted, the chain of delegation and the transfer of responsibilities are issues that are particularly relevant in the domain of services and the table (with the due refinements) could be a useful tool to visualize all this in a clearer way.

5 Concluding Remarks and Future Issues

In this paper we have proposed a novel framework aimed at constituting a common ontological foundation for services science. Let us briefly discuss what the main contributions of this approach are, and what future research directions we are considering.

1. *Revisitation of the difference between internal and external service views.* We have seen that the black box model of services based on external behaviour is too limited, and that a higher expressivity is necessary both to describe services in terms of their internal structure and to properly characterize SLAs and non-functional attributes.
2. *Improvement of the classic definition of services coming from economics.* We have seen that Hill's definition based on change is not general enough, since, for instance, it does not allow to consider services which do not necessarily produce a change, such as fire control.
3. *Focus on core actions instead of pre- and post conditions.* We have seen how pre- and post- conditions cannot by themselves capture important aspects of services, related to the way the service process is performed.
4. *Activity-based service representation.* We have seen how to describe a service in terms of a layered structure of related activities (events, in the most general sense

of this term). The separation of the various activities described in Fig. 1 allows us to properly account for non-functional properties, which instead of generically belonging to the service as a whole are attributes that characterize specific activities. In this way, it is possible to determine what aspect of a given service implementation is responsible for a certain service property. In particular, spatio-temporal attributes can be easily taken into account.

5. *Comprehensive business-oriented approach.* We have introduced a clear distinction between service commitment, service process, and service content, taking also into account important issues affecting service quality and evaluation, such as bundling and presentation activities, acquisition activities, and actions related to the service value chain.
6. *Conceptual analysis of the patterns of responsibilities across services.* We have conducted an analysis that takes into account the legal perspective, which is central with respect to service level agreements.
7. *Common framework to describe service according to different views,* in terms of more or less general constraints among the various service activities, providing an ontological foundation to the technique of *responsibility tables* introduced by Alter.

Given the preliminary nature of the present paper, many are the directions in which the analysis can be extended and enriched.

For sure, in order to be effective, this exploratory work needs to result in a formal model, that will constitute an ontology of services that, as a component of a modular social ontology, should be in the end connected with an ontology of organizations.

Acknowledgements

This work has been carried within the project ICT4Law (ICT Converging on Law: Next Generation Services for Citizens, Enterprises, Public Administration and Policymakers), funded by the Piedmont Region, as well as the project TOCAI.IT (Tecnologie Orientate alla Conoscenza per Aggregazioni di Imprese su Internet), funded by the Italian Ministry of Research, and the project CSS (Cartella Socio-Sanitaria), funded by the Autonomous Province of Trento. The initial ideas at the basis of this project have emerged from a fruitful collaboration with “Servizio Politiche Sociali e Abitative” of the Autonomous Province of Trento concerning the revision of a catalog of social services, to be shared among different Public Administrations. The first author is funded by a PostDoc grant from the Autonomous Province of Trento.

References

1. Chesbrough, H. and J. Spohrer, *A Research Manifesto for Services Science*. Communications of the ACM, 2006. **49**(7): p. 35-40.
2. Alter, S., *Service system fundamentals: Work system, value chain, and life cycle*. IBM Systems Journal, 2008. **47**(1): p. 71-85.
3. Baida, Z., *Software-aided Service Bundling - Intelligent Methods & Tools for Graphical Service Modeling*. 2006, Vrije Universiteit Amsterdam.

4. Janssen, M. and R. Wagenaar. *From Legacy to Modularity: a Roadmap Towards Modular Architectures Using Web Services Technology*. in *Electronic Government*. 2003: Springer.
5. Papazoglou, M.P. and D. Georgakopoulos, *Service-Oriented Computing*. Communications of the ACM, 2003. **46**(10): p. 25-28.
6. Traverso, P. and M. Pistore. *Automated Composition of Semantic Web Services into Executable Processes*. in *International Semantic Web Conference (ISWC'04)*. 2004. Hiroshima, Japan.
7. Vetere, G. and M. Lenzerini, *Models for semantic interoperability in service-oriented architectures*. IBM Systems Journal, 2005. **44**(4): p. 887-903.
8. Petrie, C. and C. Bussler, *The Myth of Open Web Services: The Rise of the Service Parks*. IEEE Internet Computing, 2008. **12**(3): p. 94-96.
9. Sycara, K., *Unthethering Semantic Web Services*, in *Semantic Web Services, Part 2*, D. Martin and J. Domingue, Editors. 2007, IEEE Intelligent Systems. p. 11-13.
10. Fensel, D. and C. Bussler, *The Web Service Modeling Framework WSMF*. Electronic Commerce Research and Applications, 2002. **1**: p. 113-137.
11. Roman, D., et al., *Web Service Modeling Ontology*. Applied Ontology, 2005. **1**(1): p. 77-106.
12. Weigand, H., et al., *Value-Based Service Modeling and Design: Toward a Unified View of Services* in *Advanced Information Systems Engineering*, P. van Eck, J. Gordijn, and R. Wieringa, Editors. 2009, Springer: Berlin / Heidelberg. p. 410-424.
13. Terlouw, L. and A. Albani, *An Enterprise Ontology-Based Approach to Service Specification*. IEEE Transactions on Services Computing, to appear.
14. O'Sullivan, J., *Towards a Precise Understanding of Service Properties*, in *Faculty of Information Technology*. 2006, Queensland University of Technology. p. 232.
15. Baida, Z., J. Gordijn, and H. Akkermans, *Service Ontology*. 2001, Free University Amsterdam.
16. Dumas, M., et al. *Towards a semantic framework for service description*. in *Data Semantics 9: Semantic Issues in E-Commerce 239*. 2003. Hong Kong: Kluwer.
17. Masolo, C., et al., *The WonderWeb Library of Foundational Ontologies and the DOLCE ontology*. *WonderWeb Deliverable D18, Final Report (vr. 1.0. 31-12-2003)*. 2003.
18. Castelfranchi, C., *Grounding We-Intention in Individual Social Attitudes: On Social Commitment Again*, in *Realism in Action - Essays in the Philosophy of Social Sciences*, M. Sintonen and K. Miller, Editors. 2003: Dordrecht.
19. Jennings, N.R., *Commitment and conventions: The foundation of coordination in multi-agent systems*. The Knowledge Engineering Review, 1993. **8**(3): p. 223-250.
20. Verdicchio, M. and M. Colombetti. *A logical model of social commitment for agent communication*. in *AAMAS 2003*. 2003: Elsevier.
21. Singh, M.P., *An Ontology for Commitments in Multiagent Systems: Toward a Unification of Normative Concepts*. Artificial Intelligence and Law, 1997. **7**: p. 97-113.
22. Cauvet, C. and G. Guzelian. *Business Process Modeling: A Service-Oriented Approach*. in *HICSS '08, 41st Annual Hawaii International Conference on System Sciences*. 2008: IEEE Computer Society.
23. Hill, T.P., *On Goods and Services*. Review of Income and Wealth, 1977. **23**(4): p. 315-338.
24. McCarty, L.T., *Ownership: A case study in the representation of legal concepts*. Artificial Intelligence and Law, 2002. **10**(1-3): p. 135-161.

25. Parasuraman, A., V.A. Zeithaml, and L.L. Berry, *A Conceptual Model of Service Quality and Its Implications for Future Research*. Journal of Marketing, 1985. **49**(4): p. 41-50.
26. Sasser, W.E.J., R.P. Olsen, and D.d. Wyckoff, *Management of Service Operations: Text and Cases*. 1978, Boston, MA: Allyn & Bacon.
27. Gronroos, C., *A Service-Oriented Approach to Marketing of Services*. European Journal of Marketing, 1978. **12**(8): p. 588-601.
28. Lehtinen, U. and J.R. Lehtinen, *Service Quality: A Study of Quality Dimensions*. 1982, Service Management Institute: Helsinki.
29. Lucy, W., *Philosophy of Private Law*. 2007, Oxford: Oxford University Press.
30. Hohfeld, W.N., *Some Fundamental Legal Conceptions as Applied in Judicial Reasoning*. The Yale Law Journal, 1913. **23**(1): p. 16-59.
31. Beladiez Rojo, M., *Responsabilidad e imputación de danos por el funcionamiento de los servicios públicos*. 1997, Madrid: Tecnos.
32. Perez Moreno, A., *Responsabilidad en la gestión indirecta de obras y servicios públicos*. , in *La responsabilidad patrimonial de los poderes públicos*, Martínez and Calonge, Editors. 1999, Marcial Pons: Madrid, Barcelona. p. 399-418.
33. Becker, H., *Notes on the Concept of Commitment*. American Journal of Sociology, 1960. **LXVI** p. 32-40.
34. Falcone, R. and C. Castelfranchi, *The human in the loop of a delegated agent: the theory of adjustable social autonomy*. IEEE Transactions on Systems, Man, and Cybernetics, Part A, 2001. **31**(5): p. 406-418.