

A NEW ONTOLOGICAL PERSPECTIVE FOR SOCIAL SERVICES

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

Abstract. Most of the efforts conducted on e-Government services nowadays are focusing on data workflow processes within and between PAs, often disregarding the fact that, from the citizen's perspective, what counts most is the performance of the global process involving people and organizations as well as software artefacts. Our main claim is that it is necessary to include this social dimension in reference models for e-Government services for many reasons, ranging from semantic interoperability to transparency issues. Along these lines, we sketch a preliminary definition of "service" based on an ontological analysis centred on the notion of service availability, which results in useful distinctions between service, service content, service delivery and service process. Services are modelled by means of a layered set of interrelated events, with their own participants as well as temporal and spatial locations.

1. – Introduction

When scanning the literature on e-Government services modelling, it's easy to realize that most of current efforts focus on describing *Web* services, instead of the real, *global* services that include actual people and organizations (see, for instance, [1], [2] [3], [4]). Indeed, much of attention is devoted to optimizing the performance of *data workflow* processes, often disregarding the fact that, from the citizen's perspective, what counts most is the performance of the global process involving actions and commitments of people and organizations.

We believe that, when speaking of e-Government services, we should take into account what services actually mean for Public Administrations (henceforth PAs) and for citizens. Thus, we cannot limit ourselves to modelling *data processes* within and between PAs, but we have to consider also the actual *events* happening in the world (which may or may not be synchronous with data processes), as well as the people and organizations involved in such events. In other words, when modelling (e)services, we can't model just a software application, but we must take into account the whole social system that interacts with such application, through complex chains involving people and computers, which however have always *people* at their ends. That's why in the title of this paper we emphasize the role of *social* services, although the approach we describe should be ultimately general enough to account for any kind of service.

A further reason to include people and organizations in a proper model of e-services lies in the need to establish a clear link between service process re-engineering and organizational re-engineering, accounting for the impact of e-Government on the actual structure of PAs.

This is especially important when we have to evaluate the global quality of e-Government services, since we need of course proper tools to relate the ultimate social benefits to the technology solutions adopted, taking the overall impact on the organizational structure into account.

Modelling services according to this global view is not an easy task, however, mainly because the notion of service is a subtle and ambiguous one, so that many researchers simply have given up adopting a clear definition, relying on a variety of intuitive notions mainly coming

from practical considerations, which however lack 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 Web services as exposed (aggregates of) functionalities?

In this paper we shall introduce a novel, general approach to service modelling founded on the basic principles of ontological analysis, centred on the notion of *service availability* as a temporal state resulting from an agent's commitment to perform 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 entities (processes and events), each one with its own participants and spatiotemporal location.

2. – State of the Art and Related Work

The enterprise we are carrying out in the present work, in order to succeed in giving an authentically global view on services, has to rely on a wide and multifarious literature, in which very heterogeneous concepts of service are presented. Unfortunately, most of the definitions that can be found are confusing. In this section we will try to trace a tendency that, starting from definitions that are mainly built on syntax, will hopefully end up with an ontologically founded and semantically sound definition.

The first branch of studies that is worth considering are those conducted under the scope of the W3C initiative and, more generally, aimed at the implementation of Web-based standards. In this area, the first efforts have been directed towards the creation of annotation languages enabling the description of services. Some of the most relevant results of these studies are standards such as the Simple Object Access Protocol (SOAP) [5] and the Web Service Description Language (WSDL) [6]– both based on XML– and the Universal Description, Discovery and Integration (UDDI) standard [7]. A second community that has dealt with the topic of services is the Semantic Web community, whose goal is to automate the semantic discovery, selection, invocation, composition of services through the use of appropriate service description languages and conceptual models that combine Semantic Web and Web services technologies. The most significant of these frameworks are the Web Service Modeling Ontology (WSMO) (with the related language WSML – Web Services Modeling Language) ([8], [9]) and the OWL-S language [10]. All these of course represent a great advance in semantic technologies, but are still mainly focused on languages for the description of the services rather than on the structure of services themselves, about which they make only minimal assumptions. Moreover, while they are quite successful in describing Web services, they are not as adequate for the description of other, more conventional, services.

Along these lines, the literature in business modelling has, on the other hand, provided wider representations of business activities that include (but are not reducible to) models of computer based services (see for instance [11], [12], [13], [14]). This is for sure a step forward in the direction of the global breadth that we were advocating at the beginning of this paper. Nevertheless, what is depicted in these models are workflows, processes, and all the dynamic aspects pertaining business activities, while what is still lacking is a representation of the so called “static” aspects.

Remarkable exceptions to the common trend are [15], [16], [17], [18] and [19], that based their analysis on definitions taken from the literature in economics [20] and sociology.

Following the recommendations contained in [21], in order to establish a service science, we need to find a common ontological foundation for the notion of service. This is exactly the long term goal of our work, of which this paper constitutes a starting point.

3. – The proposed Approach

3.1 – 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 PAs.

Sometimes the term “service” is used to indicate an *action* (like a useful act that someone performs), or a *type of action*, or perhaps as the *capability* to perform some action; other times it refers to 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 the citizen is referring to when asking for a service.

Curiously enough, also the definitions in the W3C glossaries, referred to Web services, present evident ambiguities:

“An application that provides computational or informational resources on request.”
Glossary for XML Key Management (XKMS 2.0) Requirements

“A program that issues policies and (possibly) data requests.”
Glossary for the Platform for Privacy Preferences 1.0 (P3P1.0) Specification

“[...]a software system designed to support interoperable machine-to-machine interaction over a network”.
Web Services Glossary

but also

“[...] an abstract resource that represents a capability of performing tasks that form a coherent functionality from the point of view of providers entities and requesters entities. To be used, a service must be realized by a concrete provider agent.”
Web Services Glossary

It is easy to see that, even in the case of restricted technical domains such as that of Web services, services are sometimes seen as processes, other times they rather resemble agents (See also WSMO’s definitions of service, for instance in [9]).

The last definition looks particularly interesting, as it takes into account various concepts: that of *abstract resource*, that of *capability*, those of *provider* and *requester* and, finally, those of *realization* and *concrete agent*.

For the moment, let us just keep in mind all these elements, to whom we will return later and come back to our main issue, that of *social* services.

Another helpful question one could pose is: “What do you *pay for*, when you invest in a service?”

The easiest way to answer is to take into consideration public services, as fire and rescue services, snow removal services, children care services, etc.

When do we say that, for instance, in a municipality there are such services? When someone is extinguishing a fire or removing an amount of snow? No or, at least, not only. We could say that there are *here and now* both a fire-and-rescue service and a snow removal service even though at this very moment here neither there are lit fires, nor is it snowing. It suffices to say that there is someone (firemen, operators of the snow removal service) who is *prepared* to perform precise actions in case something happens (fire, snow).

Our intuitive definition is thus the following:

A service is present at a time t in a location l iff, at time t, an agent is committed to guarantee the execution of some type of action at location l, upon the occurrence of a certain triggering event, in the interest of another agent (although at the cost of a certain sacrifice), in a certain way.

So, in a sense, at the core of any service there is a *commitment* situation in which someone (the service *trustee*) guarantees the execution of some kind of *action(s)* (by means of a *service provider*) in the interest of somebody (the *beneficiary*), at a certain cost and in a certain way. From the ontological point of view, this situation is a static temporal entity, i.e. a *static event* in the sense of [22]¹, which involves the participation of a single agent, the *trustee*. This commitment state typically starts at the time of the commitment act, and its duration is determined by the commitment's act itself², which typically specifies some constraints concerning the way the commitment will be fulfilled.

As we shall argue in the rest of the paper, we claim that this commitment state *is* the service, to be distinguished from the *service content*, which concerns the kind of action(s) the trustee commits to, and the *service process*, which is a set of business processes implementing the service commitment (see Figure 1). So, if not further qualified, we consider the word “service” as synonymous of “service commitment”. Note that 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 [23], [24], [25] and [26], 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 agreement³, etc.

In institutional settings, the *trustee*, the agent who commits, is typically a Public Administration. On the other hand, the *service provider* may not necessarily coincide with the trustee, and can be either a PA or another kind of (private) organization, delegated by the trustee; in some exceptional cases even an individual agent. The same holds for the *beneficiary*, who can in turn be a PA, an organization, or an individual agent, the latter being

¹ 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 [21]).

² 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.

³ In the actual practice, the term “service level agreement” may be typically used to refer to the negotiation that the provider conducts with the user; here we are using the locution in a coarser sense, which includes also the agreements between trustee and provider and trustee and user and, possibly, between trustee and the community to which services are provided.

much more common than in the previous case.

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 beneficiary (like a parent in need who requires children care); 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 action⁴. Of course, since the occurrence of the triggering event is not known in advance, the action time is in general different from the availability time, so a service may be available at a certain time even if none of its foreseen actions do actually occur.

In order to better clarify the fundamental elements involved in our intuitive definition, we go back to one of the examples previously presented, e.g. that of snow removal.

A service of snow removal is present (today in the Province of Trento) iff (today in the Province of Trento) the institution Autonomous Province of Trento is committed to guarantee snow removal from the streets (on the whole territory immediately after the occurrence of a snowfall) by the appointed operators in the interest of the residents.

It is interesting to compare the definition we have just outlined with the last of the various W3C definitions we have introduced above:

A service is “[...] an abstract resource that represents a *capability of performing tasks* that form a coherent functionality from the point of view of providers entities and requesters entities. To be used, a service must be realized by a concrete provider agent.”

We can see there are many similarities with our definition, the most obvious being the presence of providers and requesters, and the distinction between two levels: an *abstract* level, where functional capabilities find their place, and a *concrete* one, where the functionalities are *realized*. However, our notion of commitment is different from an abstract capability in two ways. First, an agent may be capable of doing something without being committed to do so (for instance, a Web service may be potentially operational but not activated). Second, our definition involves the provider agent (more exactly, the trustee) already in the notion of service, instead of confining it to the service realization only. This means that, in our approach, different agents will always guarantee different services (possibly with the same *content* – see below). This choice seems more intuitive to us: when asking “how many telephone services are there in this country?” the answer can be “Two, but they deliver the same content”.

In a sense, our definition binds together the abstract and the concrete levels, which are comprehended in an articulated unitary framework.

3.2 – The basic ontological structure of services

Let us start our analysis with a very simple question: what’s happening when a service is *delivered*? What’s happening when a service is *available*? First of all, it’s important to remark that a service may be concretely available even if it is not actually delivered, or maybe will be never delivered: for instance, we keep paying the firemen even if no fires occur. So, in our

⁴ 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 provider itself or delegated to another agent.

approach, a service is an entity (a commitment/availability status, as we have seen) which is to be distinguished from the actual service *delivery* to a particular beneficiary. 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 beneficiary. So a service is the concrete commitment (guaranteed by a *trustee*) to deliver 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 delivery (performed by the service *provider* on behalf of the trustee) constitute the *service process*. We shall say that a service process *implements* a service. Finally, the beneficiary's actions necessary to enjoy the service content constitute the *service acquisition*.

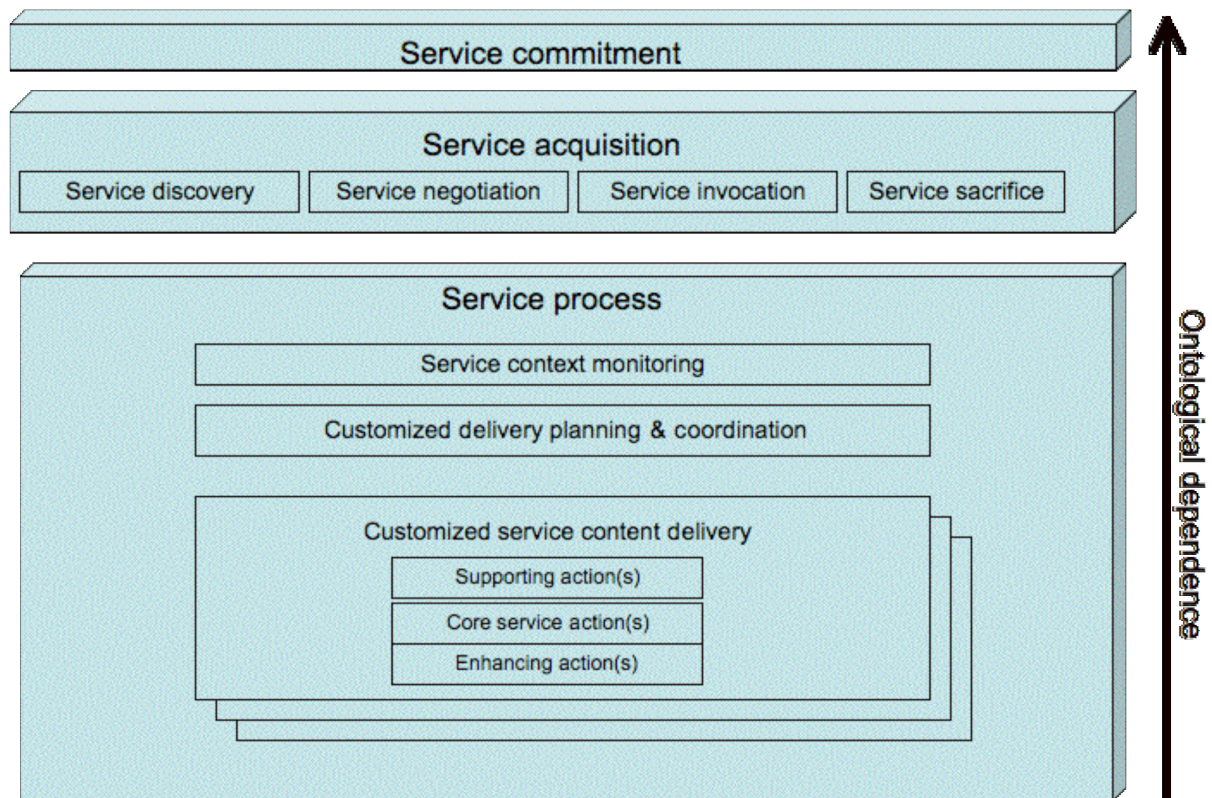


Figure 1: Services and service processes, a layered structure of dependent events

So, as illustrated in Figure 1, the notion of service articulates in three main notions: service commitment, service acquisition, and service process. Of course, the three notions are strictly intertwined; in particular, a proper grasping of the service process internal structure is necessary to specify the service commitment. 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 modeling point of view. We believe that this integrated approach is especially relevant for e-government applications, where it is necessary to account for the impact of front-office re-engineering choices based on service-oriented architectures on the back-office organization structure of Public Administrations.

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 *temporal 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. In particular, 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.

Let us now consider the various events constituting the service process. In Fig. 1, the containment relationship between the various green blocks represents the parthood relationship. The core constituent of a service process is a set of basic activities (each called *customized service content delivery*⁵), centered around the delivery of service content to a *single beneficiary*. In addition to the *core service action(s)* depending on the service nature, a customized service content delivery may include *enhancing actions* intended to increase the service value or differentiate it from those of competitors [15] as well as *supporting actions* needed to enable the core service consumption. 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 labeled 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 content delivery, which can be an external situation or a beneficiary's request: without an explicit modeling of such activity, there would be no way to account for delays or improper management of triggering events.

As a presupposition to service content delivery, typically some *service acquisition* activities are required from the side of the beneficiary⁶. These include *service discovery*, which is the event where the service trustee (or provider) and the service beneficiary first meet together; *service negotiation*, which involves an agreement between the two parties; *service invocation*, which refers to the event where the beneficiary agrees to the service (not necessarily implying immediate content delivery); and *service sacrifice* [15], which is an action whose results go somehow against some of the beneficiary's desires, but which the beneficiary is still willing to perform.

Having described the details of the service process, we can now clarify better what the internal structure of the highest level of Fig. 1 is, concerning what we consider the service itself. The latter has been defined as the commitment to deliver a service content *in a certain way*, that is, by implementing a certain *kind* of service process. So, the thematic roles

⁵ In the context of public services, a single event of customized service content delivery is often called an *intervention*.

⁶ Even in the case of free, public services, it is difficult to imagine a case where the beneficiary is not required to actually discover the service, or make a minimal sacrifice to exploit it.

involved in the definition of a service event are: the *agent*, who is the service *trustee*; the *object*, which is the service content, specified by means of the *kind* of core action(s) to be executed; the *beneficiary*, which is the agent who ultimately benefits of the service; and, finally, the *instrument*, which is the *kind* of service process to be implemented, specified by means of a set of *constraints* (first order formulas) on the various events constituting the service process (including, notably, the kind of triggering event and the expected beneficiary's sacrifice).

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 beneficiaries, 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 guarantees that the required conditions are met is usually, in e-government scenarios, a PA. The issue of PA's legal responsibilities is very complex and won't be dealt with in the present paper, but it is worth noting that responsibility is usually distributed and assigned according to some structural constraints, i.e. by devising a structure of roles and sub-organizations internal to the PA. 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 content delivery, whose beneficiaries are, ultimately, concrete agents (citizens); also the triggering situation is the occurrence of a precise (instance of) event. The service delivering level is thus 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.

3.3 – Information Services, e-Services and Web Services

The analysis and description presented above is aimed at being as general as possible and thus at being applicable to all kinds of services (at least all those managed by PAs). Among social services, a particular class can be singled out, namely that of information services, i.e. those services that manage data and information.

On the one hand these kinds of service are a specialization of social services, on the other hand, they have a peculiar nature as, in the life of PAs, they are always associated with all other kinds of service. This is because everything that involves the activity of PAs must be documented, and thus produces data. These data need to be recorded and, most of the times, communicated. Therefore, what characterizes information services and distinguishes them from other kinds of service is the type of actions that the provider (of information) performs. What triggers the execution of an information service is sometimes a request (of communication of a particular information), sometimes the occurrence of a life event which is

institutionally relevant (like the birth of a new citizen), other times is the accomplishment of some other service (like when a social assistant visits a citizen in need and a record is produced in order to keep track of how the service is being delivered).

This means that probably a way to model the coordination of different services (and, most notably, the coordination of information services and other kinds of services) could be to take an event that plays the role of end state of an intervention in a service and let it play the role of triggering situation for another service (especially for an information service).

At this point it is trivial to see that only information services can be turned into e-services or Web services. The latter can be seen as special subclasses of information services, whose means of recording and transporting are of a particular kind (electronic and Web-based respectively).

Having a model that describes both the management of data and the events that have generated such data may allow to trace not only *that* a datum is incorrect, but also *why* it is so.

4. Concluding Remarks and Future Issues

In this paper we have proposed a novel definition of service aimed at being ontologically founded and general enough to comprehend under its scope also those kinds of service provided by PAs that are not necessarily delivered using electronic means.

The need to have such a global approach to services is motivated both by interoperability and by transparency issues. Even though services have been studied and analyzed in various disciplines, accurate definitions are very rare in literature and often not reciprocally compatible. A typical problem is that different definitions refer to different events composing a service, thus creating confusion. Such events are to be kept distinct and at the same time the relations among them must be recognized. The explicit recognition and expression of the layered structure of services is one of the points of distinction of our approach with respect to other related works.

Given the preliminary nature of the present paper, many are the directions in which the analysis can be extended and enriched. As already pointed out, the relations between the different spatio-temporal locations of the interrelated events must be taken more seriously into account.

Finally, 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.

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