

Modeling Service Dynamics: a Case Study

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1 Introduction

In previous work, Ferrario and Guarino have proposed an ontological analysis of the notion of service based on the notion of commitment [1, 2]. In particular, in this approach, a service is understood as a complex process, consisting of several activities going on more or less in parallel, all dependent on a persisting *state* of generic commitment. More recently, in the framework of a cooperation project involving both LOA and NEMO, such approach has been revised and extended as a specialization of the UFO ontology [3]. In this work, on the one hand, the crucial notion of *commitment* is complemented by the dual notion of *claim*, capturing in this way the fundamental relational (contractual) nature of services; on the other hand, both commitments and claims are not understood as *states* of objects (namely, mental states of service providers or clients), but rather as *objects* in their own right, although specifically dependent, respectively, on providers or clients.

In this new view, at the core of the notion of service there is a *reified relationship* between a service provider and a (potential) *community of customers*, which is understood as a *bundle of commitments and claims*. Following Guizzardi [4], these reified relationships are called *relators* in the UFO-S ontology. This new approach does not reject commitment (or claim) states, but simply allows us to point at what these states are about, after all: specific mental attitudes of people or organizations. Most importantly, it allows for modeling the *dynamics* of service relationships, focusing on the subjects of change within such relationships: commitments and claims.

Modeling service dynamics is mostly important from the point of view of service contract management [5]. Indeed, especially for IT services, service contract conditions may be seen as a formalized description of commitments and claims, defined in the service model. They evolve in time during the whole service provision cycle, crucially depending on service level monitoring and management issues. As ITIL's Continual Service Improvement (CSI) [7] states, service terms, or provider's obligations and penalties, can be defined after a monitoring phase when real values of SLAs' KPIs are available, and monitoring procedures have been agreed between service providers and service clients.

In this paper we shall discuss our new approach to service modeling in the context of a concrete IT service case, focusing on the dynamics of service lifecycle issues concerning an Italian holding company whose IT services come from the composition of lower level services, each one with its own contract specifications [6]. In this service composition case, the need for dynamic contract and service level management and monitoring is even more dramatic, so that it represents a good test for our approach.

2 Case Study

A service, even if conceived as a whole entity during its lifecycle, is subject to several changes according to its delivery context.

Let's consider the lifecycle dynamics of the email service at a business firm with more than 5000 employees spread out into more than 100 offices all over the nation.

The service manager at the IT department is in charge of developing and delivering the email service to the whole organization. In this case study the description of the email service will be furtherly specified and enriched with new details along the lifecycle steps.

Let's suppose the service manager must specify the email service offering according to what has been defined in [2] in order to satisfy the requirements coming from his/her customer (or stakeholder) community. Meanwhile the service manager is in charge to design the service and look for providers able to deliver the (whole or part of the) services he has offered.

Let's suppose that the email service is provided via Web browser and email client, on Intranet, on Internet, and on mobile devices. The service manager has chosen to outsource the email service (mailbox management for sending, receiving, archiving, securing and anti-spamming, etc.) to provider A and the network management to provider B. Moreover email service for mobile devices (like Blackberry) is provided by a mobile network operator C. Figure 1 illustrates the network diagram for such email composed service.

Through the negotiation phase, the service manager defines commitments and claims with each provider, formalizing them into contracts' terms and conditions. Moreover the service manager must negotiate commitments and claims with his internal customer/stakeholder community and manage to relate them with the kind of obligations he/she has reached with each provider of the service components.

In service negotiation the service concept changes its shape because it becomes an actually delivered service and not anymore a promise of service.

Moreover in the contract a crucial part is related to the service delivery with specific focus on service monitoring and obligations in the case of low or absent quality of service. The service manager must clearly have in mind the different perspective of customers community and the service providers. For example let's suppose that at a certain time, from 8.00 pm to 8.30 pm of day x, a hundred users can't access the service via email client, but both mobile devices and Web clients work properly. This scenario raises several questions related to services contracts and obligations among the involved stakeholders.

First of all we envisage several stakeholders, who perceive the service and its dynamics very differently: the final user, who sends and receives emails, the contract manager who needs to know which provider is accountable of what service, the service level manager who is responsible to combine underpinning SLAs in a single SLA which is negotiated with final users or business, providers who are accountable to guarantee a service with SLAs as defined in contracts.

In the end-user perception, email service is available 24h 7x7 independently from the used channel (or IT service chain). So, in case of fault, user perceives that the service is not available (or it is at least degraded). Let's suppose for example that the network service provided by Provider B, gone down from 8.00 pm to 8.30 pm of day x, is guaranteed as available by contract in business hours (i.e. Mon-Fri, 8.00 am -6.00 pm). In this case Provider B is not responsible for the fault, as it has happened outside the guaranteed availability's time window.

In this example Service Manager is accountable for the asymmetry between the service quality expected by his/her internal customers and the quality he has negotiated through service components contract.

The last part of service lifecycle concerns the dynamic of the service conclusion. In this case of email service, it can be terminated because a service component provider change; in this case commitments and claims about backups and data retrieval must be preventively agreed. Another scenario would consider the dismissal of email service as an internal service towards a full outsourcing and the related start-up of a new service negotiation with a provider.

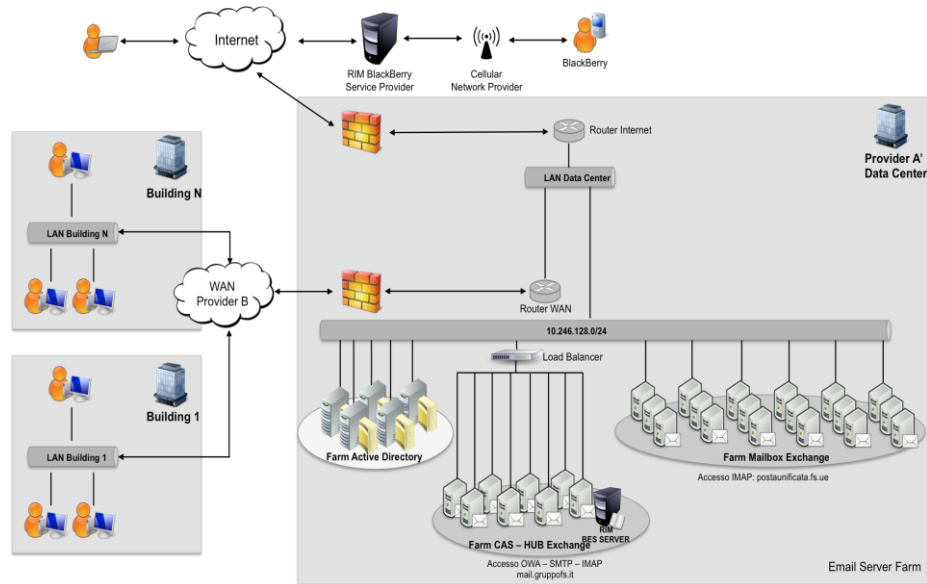


Fig. 1. An example of email service and its IT service chains from final users to the data center delivering the service

3 Modeling Aspects

UFO-S is a commitment-based service ontology whose conceptualization is based on the establishment and fulfillment of commitments and claims between service participants (used to refer to both service provider and service customer) along the service life-cycle. In this paper, we focus on the three main phases of the service life-cycle, namely: (i) service offer, when a service is presented and made available to a target customer community, (ii) service negotiation, when provider and customer(s) negotiate in order to establish an agreement about specific aspects that drive the service delivery, and (iii) service delivery, when actions are performed in order to fulfill a service agreement. Despite their relevance to certain areas of investigation (such as services marketing), we consider all service-related actions that occur before service offer and after service delivery as outside the scope of this paper.

In order to represent UFO-S, we employ OntoUML [10], an UML profile that incorporate the foundational distinctions in UFO-A and UFO-B. Table I presents the OntoUML stereotypes used in this paper. In addition to employing OntoUML to represent UFO-S, we further ground UFO-S with respect to the social and intentional concepts of UFO-C.

Table 1. A SUBSET OF ONTOUML STEREOTYPES

Stereotype	Corresponding Concept in UFO
<<category>>	Category
<<kind>>	Kind
<<collective>>	Collective Universal
<<rolemixin>>	Role Mixin
<<role>>	Role
<<mode>>	Mode Universal
<<relator>>	Relator Universal
<<event>>	Event Universal

Service Offer

Figure 2 shows an OntoUML class diagram with the main concepts and relations involved in a service offer, according to UFO-S. A *service offer* event results in the establishment of a *service offering* between a *service provider* and a *target customer community*. A service offering is composed of *service offering commitments* from the *service provider* towards the *target customer community* and the corresponding *service offering claims* from the target community towards the service provider.

What “counts as” a service offer (i.e., which actions are service offers) depends ultimately on the (social) context in which services are offered; a service offer could thus be the registration of a service provider organization in a chamber of commerce, service advertisements, face-to-face communication, etc. The context will also determine the

kinds of commitments that are established and the consequences that arise from a failure to fulfill such commitments. For example, in some legal systems, it is unlawful for an organization that has offered a service to refuse arbitrarily to provide the service to a particular customer in case no legitimate business reason is provided (in order to rule out arbitrary discrimination).

The set of statements (content) associated to the offering commitments (and corresponding claims) depends on the particular service business model, and, therefore, can refer to several different elements, such as conditions and requirements for providing the service, types of actions to be performed in the scope of service delivery, constraints, required customer's commitments (such as payment), etc. Such elements may be described in service offering descriptions (such as folders, registration documents in a chamber of commerce, artifacts in a service registry, etc.).

Take as example the case of a car rental service. When this service is offered by a particular car rental office called Highway (e.g., through advertisements), the car rental office plays the role of a service provider. It commits, under certain conditions, to grant temporary use of a vehicle to the customer. Examples of such conditions include minimum period of rental, car availability, qualifications and properties of the renter (e.g., should be a registered driver older than 21), expected payment guarantees, minimal rental period, etc. The members of the target community are entitled to rent a car if all conditions are fulfilled.

What is established in a service offering also determines the level of flexibility for a subsequent service negotiation phase, in which a particular service customer and a service provider establish a particular service agreement. Because of that, offering commitments are in fact meta-commitments (i.e., they are commitments to accept commitments), because they refer to commitments that can be established later during the negotiation phase and that do not yet exist as a result of a service offer alone.

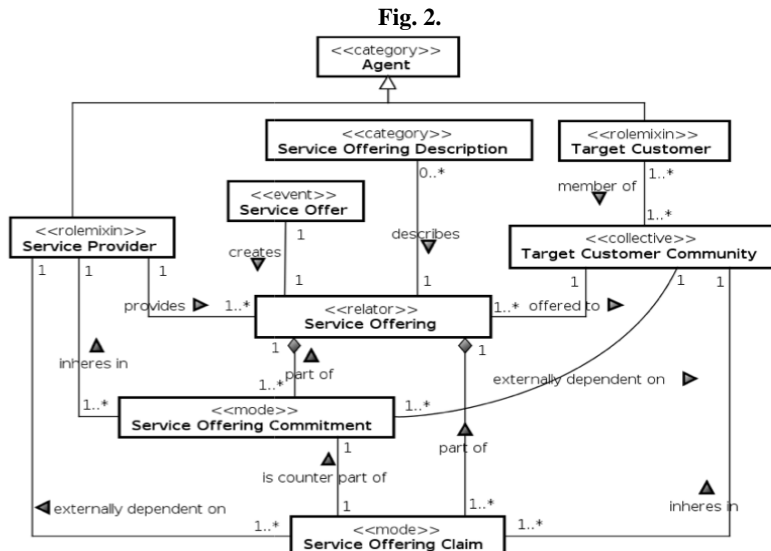
Agent is a category that represents the essential properties of any type of agentive substantial, such as person, organization, or software agent, which may have distinct principles of identity. Service provider is the role played by agents when these agents commit themselves to a target customer community by a set of offering commitments. In terms of UFO, service provider is a role mixin, since it can be instantiated by agents of different kinds, e.g., persons and organizations. Target customer community is a collective that refers to the group of agents that constitute the community to which the service is being offered. The community has an intensional principle of identity, in the sense that agents can enter or leave the community without altering the community's identity. The intensional criteria for defining the target customer community are included in the content of the service offering. This may range from offerings with no restrictions to strictly targeted service offerings.

The target customer is the role played by agents when they become members of a target customer community and, as consequence, have claims for the fulfillment of the commitments established by the agent playing the role of service provider. A service offering is the social relator that arises from the service offer event, and that can be described in service offering descriptions, i.e., normative descriptions in UFO-C. A service offering is the aggregate of offering commitments and the corresponding claims. Service offering commitments and claims are social moments (in the sense of

UFO-C), i.e., offering commitments are intrinsic moments, which inhere in the meta-committed agent (acting as service provider) and are externally dependent on the target customer community. Offering claims, in turn, are intrinsic moments that inhere in the target customer community and are externally dependent on the meta-committed agent (acting as service provider).

B. Service Negotiation

Figure 3 shows an OntoUML class diagram with the main concepts and relations involved in service negotiation, according to UFO-S. Once a service is offered, service negotiation may occur. In general, service negotiation is motivated by the interest of a target customer in the service offering, considering its contents (including the conditions to be satisfied by the service customer in the case it should hire the service). During service negotiation, service provider and target customer interact in order to establish an agreement regarding their commitments and claims with respect to an eventual service delivery. If service negotiation succeeds, a service agreement is established, and the service provider starts to play the role of *hired service provider*, while the *target customer* starts to play the role of *service customer*. Like a service offering, a service agreement is composed of commitments and claims. However, differently from the service offering, in a service agreement service customers may also establish commitments to service providers (e.g., the commitment to pay). Service agreement involves not only commitments from the hired service provider towards the service customer, but may also involve commitments from the service customer towards the hired service provider. Thus, these two participants become co-responsible for the service delivery. Service agreement should conform to what was previously established in the corresponding service offering.



This is exactly the relation between the meta-commitments in the offering and the commitments in the agreement. An agreement X conforms to an offering Y if for every metacommithment mc in Y , there is a commitment c in X such that: any situation which satisfies the propositional content of c satisfies the propositional content of mc (and mutatis mutandis for claims). As in the case of service offer, what is agreed between the parties depends on the context of the service agreement, as well as on the particular service business model, and, therefore, can refer to several different elements. These elements may be described in *service agreement descriptions*. Returning to the case of the car rental service, when John, a particular target customer, goes to the Highway car rental office and rents a car, he becomes a service customer, whereas Highway acts as a hired service provider. John and Highway commit themselves to perform some actions and to respect certain conditions. Examples of these conditions include amount to be paid per day, period of rental, conditions of the vehicle and so on. These conditions are registered in a contract. In terms of UFO-C, service negotiation is an *interaction* involving the participations of the service provider and the target customers. When service negotiation (an *event*) succeeds, this event is the foundation for a service agreement (a *relator*). Hired provider and service customer commitments and claims are *social moments*. Hired provider commitments and claims are intrinsic moments that inhere in a hired service provider and are externally dependent on a service customer. Service customer commitments and claims are intrinsic moments that inhere in a service customer and are externally dependent on a hired service provider. In a manner analogous to how a service offering (as a social relator) mediates the relation between service provider and target service customers by aggregating offering commitments and claims, a *service agreement* mediates the relation between hired service provider and service customers.

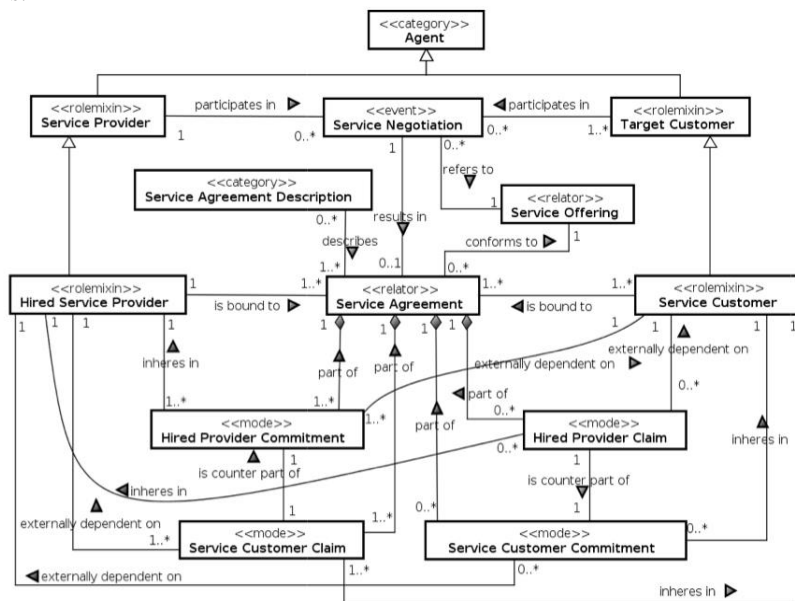


Fig. 3. Service Negotiation

The role of *hired service provider* is played by an agent *A*, when this agent commits itself to an agent *B* (playing the role of service customer) to perform actions or to achieve the results determined in the service agreement. This means that service agreement includes a delegation relation: when establishing a service agreement, agent *B* who plays the role of service customer, delegates a goal/plan to the agent *A* who plays the role of hired service provider. Thus, claims of *B* towards *A*, and commitments of *A* towards *B* are created, since *A* has committed to pursue the delegated goal or to execute the delegated plan. When agent *B* delegates a goal/plan to agent *A*, *B* becomes (at some level) dependent on *A*. Thus, before hiring a service (and, therefore, establishing a delegation), the customer typically makes an analysis of feasibility, not only associated to monetary aspects, but also to aspects such as dependency, rights, and commitments to be established. Considering the notion of co-responsibility arisen by the mutual commitments, the hired service provider also depends on the service customers for the fulfillment of their own commitments (e.g., a consultancy firm needs access to information from customers in order to provide its services). Thus, in the context of a service agreement, the agent who plays the role of hired service provider (*A*) is also dependent on the agent who plays the role of service customer (*B*).

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